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[6560-01]

ENVIRONMENTAL PROTECTION AGENCY

[40 CFR Part 141]

[FRL 851-51]

INTERIM PRIMARY DRINKING WATER REGULATIONS

Control of Organic Chemical Contaminants in Drinking Water

AGENCY: Environmental Protection Agency.

ACTION: Proposed Rule.

SUMMARY: This proposed amendment to the National Interim Primary Drinking Water Regulations is intended to protect the public health from organic chemical contaminants in drinking water. The Administrator has determined that the presence in drinking water of chloroform and other trihalomethanes, and synthetic organic chemicals may have an adverse effect on the health of persons and that therefore human exposure to these chemicals should be reduced.

DATES: All comments should be submitted in triplicate by May 31, 1978. Proposed effective dates: See Supplementary Information. Hearing dates: See Supplementary Information.

ADDRESSES: Submit comments in triplicate to: Victor J. Kimm, Deputy Assistant Administrator for Water Supply, Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460. Hearing addresses: See Supplementary Information.

FOR FURTHER INFORMATION CONTACT:

Joseph A. Cotruvo, Director, Criteria and Standards Division, Office of Water Supply (WH-550), Room 1111, WSME, Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460. 202-755-5643 or 202-472-5016.

SUPPLEMENTARY INFORMATION:

This proposed amendment to the National Interim Primary Drinking Water Regulations is intended to protect the public health from organic chemical contaminants in drinking water. It consists of two parts: I—a Maximum Contaminant Level (MCL) of 0.10 mg/l (100 parts per billion) for total trihalomethanes (TTHM's) including chloroform, which occur in drinking water as the result of the interaction of the chlorine applied for disinfection and other purposes, with the organic substances which naturally occur in raw water, and II—a treatment technique requiring the use of granular activated carbon in the treat-

ment process for the control of synthetic organic chemicals associated with industrial pollution and urban and agricultural run off contaminating drinking water supplies. The Administrator has determined that the presence in drinking water of chloroform and other trihalomethanes; and synthetic organic chemicals may have an adverse effect on the health of persons and that therefore human exposure to these chemicals should be reduced.

The MCL for total trihalomethanes (TTHM's) is initially applicable only to community water systems serving a population of greater than 75,000 people and which add a disinfectant to the water in any part of the treatment process. Prior to the effective date, these water systems are required to conduct monitoring under section 1445 of the Safe Drinking Water Act.

Community water systems serving populations between 10,000 and 75,000 are only required to monitor for the level of TTHM's in their systems for one year. Community water systems serving fewer than 10,000 persons are not required to comply with the MCL or conduct monitoring under this regulation.

Additional microbiological monitoring is required for systems that change their treatment practices as a result of this regulation to ensure that no degradation in bacteriological quality of the drinking water occurs as a result of any such modification.

In addition this proposed regulation limits the application of two of the disinfectants, chlorine dioxide and chloramines, which might be utilized in place of chlorine to reduce THM generation.

The treatment technique regulation initially requires community water systems with populations greater than 75,000 people to use granular activated carbon in their drinking water treatment systems. Community water systems which demonstrate that this treatment is not necessary to protect the health of persons due to the nature of their raw water source may be granted a variance from the treatment technique requirement. A system may also be granted a variance to use an alternative treatment technique if it can demonstrate to EPA's satisfaction that its proposed alternative is at least as effective as granular activated carbon in reducing synthetic organic chemicals in drinking water.

Unless a community water system subject to the treatment technique is granted a variance, it is required to design, construct and operate a treatment system which uses granular activated carbon (GAC) to reduce the level of synthetic organic chemicals to the maximum extent feasible and is designed to meet specified criteria.

In some cases, these criteria may be achieved through addition of GAC in

the existing system with only the carbon reactivation frequency being affected. In many cases, however, economics or practical feasibility will require the design and construction of post-filtration contactors and on-site reactivation facilities. In the latter cases, the regulation provides 3½ years after the effective date for design and construction of filters and furnaces.

Optimal design specifications, including contact time, type of carbon and regeneration frequency to meet the effluent criteria are to be determined on a case-by-case basis for each system, with approval by EPA or the State Director where the State has primary enforcement responsibility. The State is further authorized to impose such monitoring, operation and maintenance, and reporting requirements as it deems necessary to assure that the system, once completed, is being operated to minimize the presence of synthetic organic chemicals in the drinking water.

In addition, as an interim measure, some systems are required to replace the media in the existing filters of their treatment plants with GAC.

As additional operating and technical experience is gained with respect to the use of alternative disinfectants and the use of GAC in the treatment of drinking water, the scope of these regulations will be expanded to include smaller community water systems. In accordance with the requirements of the SDWA, Revised Primary Drinking Water Regulations will be forthcoming which will impose additional MCL's on organic chemicals as well as require further reductions in the levels of THM as additional toxicological, technological and analytical information becomes available.

PROPOSED EFFECTIVE DATES

I. MCL for TTHM's—Monitoring requirements for water systems serving more than 75,000 individuals would become effective 3 months from the date of promulgation. Monitoring requirements for water systems serving between 10,000 and 75,000 individuals would become effective 6 months from the date of promulgation. The MCL for TTHM's under section 141.12(c) and the alternative disinfectant limitations under section 141.21 (j) and (k) would become effective 18 months after the date of promulgation.

II. Treatment Technique Requirements—The effective date of the treatment technique regulation is 18 months after its promulgation. By the effective date, community water systems serving a population of greater than 75,000 individuals and desiring a variance from the requirement must have submitted a request for a variance. Within 6 months after the effective date, systems not granted a variance must submit design specifications

based on the results of pilot studies of the GAC treatment system. Within 18 months after the effective date, they must submit their final design plans and a construction schedule. Finally, by 3½ years after the effective date, all systems must have a GAC treatment system in operation in compliance with the regulations.

Some systems will, in addition, be required to implement an interim control measure of replacing their existing filter media with GAC within 12 months after the effective date of these regulations. Systems which demonstrate to the State either that they will have a GAC treatment system in operation within 24 months after the effective date of these regulations, or that due to compelling circumstances related to physical constraints at the treatment plant, it would be infeasible to replace their existing filter media with GAC, could have the interim requirement waived by the State.

Comments: Comment is solicited on all technical, economic and policy aspects of this proposed regulation, including the selected Maximum Contaminant Level for TTHM's, proposed treatment technique requirement, population coverage and phasing concept. The following are a number of issues to which EPA would like particular attention addressed in the public comments:

I. MCL for TTHM's. 1. The reasonableness of the concept of phasing the application of the regulation by making the MCL mandatory initially only for large water systems and for the time being requiring monitoring only in others, and no requirements in the smallest systems. Should the regulations differentiate in their application between ground and surface water supplies? Are monitoring frequencies sufficient to identify locations with high TTHM levels?

An alternative approach on which public comments are solicited would be to make the MCL applicable to all public water systems and affect phasing of implementation by establishing a deferred monitoring schedule. Systems serving more than 75,000 people would be required to begin monitoring within one year of promulgation, systems serving between 10,000 and 75,000 would be required to begin monitoring within three years and all other communities within five years.

2. The magnitude of the MCL at 0.10 mg/l. Does the current information warrant more restrictive regulations at this time, for example, 0.050 mg/l or less? How rapidly can the MCL be reduced to lower feasible levels?

3. The feasibility and timing of the treatment modifications that will be necessary to achieve compliance. Will 18 months provide adequate time for most impacted systems to take steps to come into compliance?

4. The economic impact on large, medium, and small water systems either for the proposed regulation or for more restrictive regulations. Are EPA's estimates of the cost of compliance reasonable?

5. The concept of averaging the concentrations of the TTHM's for compliance—both the annual averaging of quarterly samples, and the averaging of representative samples within the distribution system.

6. The use of the Standard Plate Count as a more sensitive indicator of microbiological quality while treatment modifications are being introduced and the limitations on chlorine dioxide and chloramines.

II. Treatment Technique: 1. Limiting the application of the treatment technique initially only to large water systems of greater than 75,000 population. If the initial coverage of the regulation was extended to cover all community systems serving populations greater than 10,000 rather than those greater than 75,000 population contained in this proposed regulation, an additional 2,300 systems would be covered; of which about 500 systems would be required to modify treatment, and the associated capital costs would rise from 350 to 400 million to slightly under one billion dollars. Such an expansion in coverage would provide protection to another 60 million citizens but the associated administrative problems for the States and EPA in this new area of responsibility would be significantly increased as coverage expanded from 390 to 2,700 systems. How rapidly should the phasing to include smaller systems be instituted?

2. The use of the variance process to relieve from the treatment technique requirement systems that can demonstrate that their raw water sources are not subject or likely to be subject to synthetic organic chemical contamination. Are the existing criteria sufficiently clear to allow unambiguous determinations to be made?

3. The feasibility and desirability of an interim control measure requiring replacement of existing filter media with granular activated carbon to more quickly reduce chemicals in drinking water while optimal measure are being developed by the system.

4. The feasibility and timing of the treatment technique requirements, including the interim control measures and intermediate milestones.

5. The soundness and reasonableness of the 3 criteria specified for determining the design parameters for the treatment technique.

6. The validity of the assumption that variances would be more readily justified for systems with raw water sources such as the Great Lakes, deep ground water, and protected surface waters.

7. The information which should be considered in granting or denying a variance. Is the demonstration now required to be made by a system seeking a variance too stringent or too lenient?

8. The existence of alternative treatment techniques which are at least as effective as GAC in reducing levels of a broad spectrum of synthetic organic chemicals in drinking water.

9. The feasibility of the time frame established for the monitoring requirements associated with obtaining a variance from these treatment regulations.

10. The reasonableness of the estimated costs of compliance for the affected community water systems.

EPA understands that the introduction of new interim primary regulations at this time will necessitate that States with primary enforcement responsibility modify their existing regulations or laws. In addition, modification of laws or regulations might be needed in some states to permit the use of disinfectants other than chlorine where chlorination is now specified, if these options are to be available for compliance with the MCL for TTHM's, or for replacement of existing filter media with GAC. Comment is requested from each State as to whether sufficient time has been provided to accomplish those changes so as to make the State regulations consistent with the national interim primary regulations by their effective date.

All comments should be submitted by May 31, 1978, in triplicate to expedite review to: Victor J. Kimm, Deputy Assistant Administrator for Water Supply, EPA, 401 M Street SW., Washington, D.C. 20460. Later comments will be considered as time permits.

Supporting documentation: The following supporting documentation referenced in this preamble and available on request includes the Advance Notice of Proposed Rulemaking (ANPRM) titled "Control Options for Organic Chemicals in Drinking Water" (41 FR 28991, July 14, 1976) and a review of public comments received on the ANPRM; a report titled, "Drinking Water and Health" (June 1977) prepared for EPA by the National Academy of Sciences; synopses of data from the National Organics Reconnaissance Survey (NORS), (EPA, MERL, 1975), and the National Organics Monitoring Survey (NOMS), (EPA, Office of Water Supply, 1977), the "Interim Treatment Guide for the Control of Chloroform and other Trihalomethanes" (EPA, Water Supply Research Division, MERL, June 1976); "Statement of Basis and Purpose for the Regulation of Trihalomethanes" (EPA, Office of Water Supply, 1977); the "Economic" Impact of a Trihalomethane Regulation for Drinking

Water" prepared by Temple, Barker and Sloane, Inc. (EPA, Office of Water Supply, August 1977); copies of two analytical procedures for trihalomethane analyses, the "purge and trap" method; and the liquid/liquid extraction method; "Statement of Basis and Purpose for an Amendment to the National Interim Primary Drinking Water Regulations on a Treatment Technique for Synthetic Organic Chemicals," (EPA, Office of Water Supply, 1977); "Economic Analysis of Proposed Regulations on Organic Contaminants in Drinking Water" prepared by Temple, Barker and Sloane (EPA, Office of Water Supply, 1977); and "Draft Interim Treatment Guide for the Control of Synthetic Organic Contaminants in Drinking Water using Granular Activated Carbon," (EPA, Water Supply Research Division, 1978).

Requesters should specify which of the documents is desired.

Further information. Requests for supporting documentation listed above and for further information should be sent to: Joseph A. Cotruvo, Director, Criteria and Standards Division, Office of Water Supply (WH-550), Room 1111, WSME, Environmental Protection Agency, 401 M Street, SW., Washington, D.C. 20460, 202-755-5643 or 202-755-5016. Public comments and supporting documentation will be available for inspection at the above address and at the EPA Public Information Reference Unit, Room 2922, 202-755-2808. As provided in 40 CFR Part 2, a reasonable fee may be charged for copying services. Copies of all supporting documentation will also be available for inspection at all 10 (ten) EPA Regional Offices.

In addition to considering public comments sent to EPA in a timely manner, the Agency will hold public hearings at several locations to receive comments and statements on the proposed regulations from interested persons. Hearings will be held in Miami, New Orleans, Boston, Los Angeles, St. Louis, Louisville, and Washington, D.C. Scheduled locations include:

Miami, Fla., March 23, 1978, Sheraton for Ambassadors, Crystal Ball Room, 9 a.m.

New Orleans, La., March 29, 1978, Council Chambers, City Hall, 9 a.m.

Boston, Mass., April 6, 1978, J. F. Kennedy Federal Building, 20th Floor Conference Room, 9 a.m.

Los Angeles, Calif., April 11, 1978, Los Angeles Convention Center, Rm. 214, 1201 S. Figueroa St., 9 a.m. and 7:30 p.m.

St. Louis, Mo., April 25, 1978, Fed. Bldg. Auditorium, 405 S. 12th St., 9 a.m.

Louisville, Ky., April 27, 1978, Galt House, Cochran Ball Room, 4th and River Sts., 9 a.m.

Washington, D.C., May 5, 1978, Waterside Mall, Room 3906, 401 M St., SW., 9 a.m.

Persons who wish to make statements at these hearings are urged to submit written copies of their remarks in triplicate if possible at the time they are presented for inclusion in the record. Persons wishing to attend are also urged to confirm by telephone the exact locations and times of the hearings.

BACKGROUND

Under Section 1401(a)(1) of the Safe Drinking Water Act (SDWA), 42 U.S.C. § 300(f) et seq., EPA is required to prescribe National Primary Drinking Water Regulations for those contaminants which the Administrator determines may have an adverse effect on human health. In the House Report, No. 93-1185, which accompanied the passage of the Act, Congress strongly emphasized the preventive philosophy underlying the Act (see House Report at p. 10). Conclusive proof of an adverse effect is not a prerequisite to regulation. This is particularly important with respect to the Agency's authority to control organic chemicals in drinking water since these chemicals are most often found in only very small amounts. Even at these low levels, however, they are believed to pose a significant health risk to consumers of drinking water as a result of long-term exposure. Particularly, there is evidence to suggest that such exposure may increase the risk of human cancer and other chronic effects. Thus, although it is not possible to quantify the harm caused by these chemicals, the Administrator has determined, based upon the toxicological and epidemiological data presently available, that the presence of organic chemicals in drinking water may have an adverse effect on human health and therefore should be controlled.

Under Section 1412(a)(2) of the SDWA, Interim Primary Drinking Water Regulations are required to protect health to the maximum extent feasible using treatment methods which are generally available (taking costs into consideration) when the Act was enacted. On December 24, 1975, EPA promulgated Interim Primary Drinking Water Regulations, 40 CFR Part 141, 40 FR 59556 et seq., which became effective on June 24, 1977. These regulations only controlled organic chemicals to the extent of establishing Maximum Contaminant Levels for six organic pesticides based upon data then available to the Agency. An MCL for carbon-chloroform extract (CCE) was proposed by EPA during the rulemaking process but was subsequently deleted from the final regulations because it was determined that CCE had many failings as an indicator of health protection from organic chemical contamination (see 40 FR at 59568-59569). Nevertheless, at the time it promulgated the Interim Pri-

mary Regulations in December 1975, the Agency noted that when sufficient information concerning organic chemicals was derived from ongoing monitoring and other research programs, the Interim Primary Regulations would be amended as authorized under Section 1412(a)(1) of the Act (40 FR at 59568).

Concurrent with the promulgation of the Interim Regulations, EPA published Special Monitoring Regulations under Section 1445 of the Act, aimed at gathering a comprehensive data based on the occurrence of the organic chemicals in drinking water, and on means for determining their presence. This resulted in the National Organic Monitoring Survey (NOMS).

On July 14, 1976, EPA published an Advance Notice of Proposed Rulemaking (ANPRM), titled "Control Options for Organic Chemicals in Drinking Water" 41 FR 28991 et seq.). The ANPRM described the many facets of the issue of organic chemicals in drinking water including the legislative background, health effects data, the state of available control technology and costs. Advantages and disadvantages of various regulatory and nonregulatory options were examined, and the ANPRM solicited comments and information regarding the problem and options presented.

The ANPRM addressed the problem of organic contaminants in general, placing emphasis on the monitoring and control of specific chemical groups, particularly chloroform and the other trihalomethanes, as well as the treatment approach for controlling organic chemicals in general, including the use of Granular Activated Carbon.

Over 100 comments were received on the ANPRM, and the consensus of those comments was that when sufficient information becomes available, organic contaminants should be controlled by means of establishing Maximum Contaminant Levels (MCLs) rather than by establishing required treatment techniques, and that surrogate parameters, if available, would be preferred over limits for individual compounds. Many of the compounds contained expressions of concern over the lack of data in support of regulation of the broad spectrum of organic contaminants. The comments generally supported the control of contaminants or groups of contaminants for which evidence of hazard to health could be presented.

Since the appearance of the ANPRM, a considerable amount of additional data on the occurrence and treatment of synthetic organic chemicals, and on possible human health effects from consumption of drinking water has become available. The NAS report "Drinking Water and Health" was released in June 1977 and provides

the most comprehensive compilation of data presently available on the health effects of organic chemicals in drinking water. Additional toxicological information, particularly on drinking water concentrations, as well as epidemiological studies, suggest the possibility of a drinking water variable related to a human health risk. Although granular activated carbon (GAC) was a treatment technology available at the time the Act was passed, its use by the American waterworks industry was very limited. Pilot and full scale demonstration projects utilizing GAC and other adsorbents have given further assurance of the practical feasibility of the application of GAC in drinking water treatment plants.

The Administrator has concluded that the regulation of both THMs and synthetic organic chemicals in drinking water should be initiated at this time by amending the National Interim Primary Drinking Water Regulations. Consideration was given to the issuance of these requirements as part of the Revised Primary Drinking Water Regulations since there is no question that Congress expected the Revised Regulations to include such controls. However, it is equally clear that the establishment of Interim Regulations for these chemicals was left to the Administrator's discretion based upon the availability of data which would provide sufficient support for such Agency action.

Both in the House Report and the floor debate accompanying the passage of the Act, Congress expressed concern with the presence of organic chemicals in drinking water. Due to their increasing influx into the environment and their extreme variation, Congress anticipated that organic chemicals would be regulated as a group. A comprehensive approach to standard-setting was encouraged. As a first step toward comprehensive control of organic chemical contamination of drinking water, it is consistent with the purpose of the Act to propose these regulations as amendments to the Interim Regulations.

The Agency's failure to include more comprehensive requirements governing the control of organic chemical contaminants in drinking water in the Interim Regulations promulgated in December 1975 has been the subject of litigation and continued Congressional concern. A decision in the court suit brought by the Environmental Defense Fund in the United States Court of Appeals for the District of Columbia Circuit seeking more comprehensive control of organic chemicals under the Interim Regulations is still pending. During the Congressional debates over the amendments to the Safe Drinking Water Act in July 1977, the Agency was also criticized for its

failure to control organic chemicals. It was noted that the 1962 Public Health Service standards had indicated such a need and indeed had included a standard for carbon-chloroform extract (CCE). The Congressional floor managers urged EPA to update its regulations to include more comprehensive controls for organic chemicals. The authorization for EPA to conduct additional studies on organic chemicals in drinking water was accompanied by the explicit caveat that such studies should not delay the standard-setting process.

Based upon further information presently available, it is necessary to proceed with efforts to reduce the level of organic chemicals in drinking water in the earliest feasible time-frame. Such controls take time to implement and it would not be prudent to delay the imposition of controls while the means are available. The Revised Regulations will be promulgated concurrent with the establishment of recommended maximum contaminant levels and will seek to establish long-range requirements based upon the most current toxicological, occurrence and technological information available at that time. By amending the Interim Primary Regulations as authorized by the Act to include more comprehensive control of organic chemicals, the Agency is clearly acting consistent with the congressional intent to protect the public health to the maximum extent feasible using control methods which have been available since the Act's passage.

ORGANIC CHEMICALS IN DRINKING WATER

More than 700 specific organic chemicals have been identified in various drinking water supplies in the United States. These compounds result from such diverse sources as industrial and municipal discharges, urban and rural runoff, and natural decomposition of vegetative and animal matter, as well as from water and sewage chlorination practices. Compositions and concentrations vary from virtually nil in protected groundwater to substantial levels in many surface waters and contaminated ground waters.

Organic chemical contaminants in drinking water can be divided into two major classes: those of natural origin and those of synthetic origin. The natural substances represent by far the greatest portion and consist primarily of undefined humus and fulvic materials and others produced by normal organic decomposition or biotic transformation and are not known to be harmful in themselves.

The synthetic chemicals in water can be subdivided into two groups. The first group consists of those chemicals that result from water

treatment practices (e.g. trihalomethanes). Recent EPA studies indicate that, except for certain cases, the trihalomethanes constitute the largest portion of the identifiable synthetic chemicals in drinking water. Unlike other synthetic chemicals, chloroform and other trihalomethanes are formed during the treatment process. They are thus found in virtually every drinking water supply that is disinfected with chlorine, and not uncommonly at concentrations of several hundred parts per billion (ppb or micrograms per liter).

Studies by Sontheimer and Kuhn indicate that the THMs may represent only a portion of the total halogenated products of chlorination of water. Methods are being developed to quantify the total halogenated organic compounds produced during chlorination; however, for other than the chlorinated phenols and a few other substances, identification is very difficult.

Halogenated organics such as carbon tetrachloride, chloroform and hexachloroethane have also been detected at parts-per-million levels as contaminants in chlorine. Chlorine manufactured by the graphite-anode process is more likely to have higher levels of organics than chlorine from metal anodes, particularly if the chlorine has not been "scrubbed" properly after manufacture. Chlorine used for potable water disinfection should be of the highest purity to avoid introduction of these by-products into drinking water.

The second group of synthetic chemicals consists of those chemicals introduced as a result of point and non-point sources of pollution. Nationally, both surface waters and to a lesser degree ground waters are contaminated with a variety of these pollution-related synthetic organic chemicals ranging generally from the lower molecular weight halogenated hydrocarbons and monocyclic aromatic compounds to higher molecular weight pesticides, polycyclic aromatic compounds, and pesticide-like compounds.

These classes of compounds have been found in drinking water using gas chromatography or gas chromatography/mass spectroscopy. However, the large bulk of organic matter (primarily natural products but also higher molecular weight synthetics) in water is not amenable to detection by these commonly used methods. Those organic contaminants which have been identified in drinking water constitute only a small percentage of the total amount of organic matter present.

Because the chemicals thus far identified in drinking water account for only a small fraction of the total organic content, the possibility, and indeed the probability, exists that additional substances of equal or greater toxicological significance may be pre-

sent but remain undetected by present monitoring capabilities.

Recent studies provide abundant evidence of the presence of organic chemicals in drinking water. A 1972 report on pollution in the lower Mississippi River indicated a link between compounds present in the wastes of industrial discharges and those chemicals detected in the raw and treated water supplies in that area. A more thorough examination of the finished drinking water in the New Orleans area was conducted in 1974 using the most sophisticated analytical methods available. Concentrations of 82 tentatively identified organic compounds ranged from 0.004 µg/l to 12 µg/l (ppb).

In 1974 additional monitoring of 10 cities for a broad range of organic compounds was conducted as part of the National Organics Reconnaissance Survey (NORS). Contamination of finished water supplies revealed the presence of 129 organic compounds, attributable to industrial, agricultural and municipal sources. A ground water source was also found to be contaminated.

The most recent comprehensive data on the presence of organic chemicals in drinking water can be found in the National Organics Monitoring Survey (NOMS) in 1976 and 1977. The NOMS was intended to provide a more comprehensive survey of synthetic organic contaminants in finished drinking water by monitoring for approximately 20 specific organic compounds as well as such general organic indicators as Total Organic Carbon (TOC) and Carbon Chloroform Extract (CCE).

The NOMS data clearly demonstrated that the THMs have the greatest occurrence in finished water. A large number of other synthetic chemicals were also detected at lower levels. Some apparent correlation could be found between TOC and THM, but no correlations could be made for the remaining organics and any of the surrogate indicators used.

As the sensitivity of analytical methods has improved, greater numbers of organic compounds have been found. Ongoing studies being conducted by EPA's National Screening Program will further help to identify those water systems vulnerable to contamination by organic chemicals.

PART I: TRIHALOMETHANES

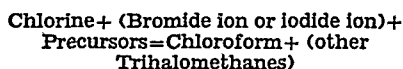
The trihalomethanes found in drinking water are members of the family of organohalogen compounds which are named as derivatives of methane, where three of the four hydrogen atoms have been replaced by three atoms of chlorine, bromine or iodine. Ten distinct compounds are possible by various combinations of three halogenated atoms, one hydrogen and carbon atom. Current analytical technology applied to drinking water has

thus far detected chloroform (trichloromethane), bromodichloromethane, dibromochloromethane, bromoform (tribromomethane) and dichloriodomethane.

The principal source of chloroform and other trihalomethanes in drinking water is the chemical interaction of the chlorine added for disinfection and other purposes with the commonly present natural humic and fulvic substances and other precursors produced either by normal organic decomposition or by the metabolism of aquatic biota. Recent EPA studies of the chlorination of certain algae in culture indicate the formation of THM. The actual human exposure potential, however, will vary depending upon the season, contact time, water temperature, pH, type and chemical composition of raw water and treatment methodology.

Since the natural organic precursors are more commonly found in surface water, water taken from a surface source is more likely than ground water (with notable exceptions) to produce high THM levels.

Generally, the THM producing reaction is as follows:



Chloroform is the most common trihalomethane found in drinking water and it is also usually present in the highest concentration. In a number of cases the concentrations of the brominated trihalomethanes were found to far exceed the chloroform concentrations. The mixed trihalomethanes appear to form by way of an initial oxidation of bromide ion in solution by added chlorine, followed by rapid and apparently preferential bromination of the organic precursors. Bromine may also be introduced as a contaminant of chlorine.

Iodination probably occurs by a similar process, however, the details are less well understood. Dichloriodomethane has been detected in drinking water along with the chlorinated and brominated THMs but it is not included

in the present regulation because of analytical and quantification difficulties. Chloroform is also a common contaminant in chlorine.

Chloroform and other trihalomethanes were first reported in drinking water in late 1974. EPA initiated the National Organics Reconnaissance Survey (NORS) of 80 water utilities, which confirmed that THMs were being formed during chlorination in the drinking water treatment process. Water samples were collected at the treatment plant and iced for shipment but not dechlorinated. Concentrations in finished water appeared to be roughly related to the amounts of natural chemicals present in the water.

In late 1975, EPA initiated the National Organics Monitoring Survey (NOMS) in 113 cities throughout the United States, and this study is now virtually complete. The NOMS expanded on the NORS by including analyses for THMs throughout the year in three phases at each utility, as well as quantifying a large number of other synthetic chemicals found in the water. THM samples were collected at water treatment plants and also in the distribution systems. Phase I analyses in the NOMS were conducted similarly to the NORS. Phase II analyses were performed after the THM-producing reactions were allowed to run to completion (terminal). Phase III analyses were conducted on both dechlorinated samples and on samples that were allowed to run to completion (terminal).

The NOMS demonstrated that considerable amounts of THMs could form in the water after it has entered the distribution systems on the way to the consumer's tap. It also showed that THMs far exceeded the concentrations of other synthetic organic contaminants in finished drinking water, and that brominated THMs could also exceed the chloroform concentrations. Part of the THM concentration variation between Phases I, II, and III might also be attributable to seasonal effects. Additional information on these studies is contained in Table I and in the "Statement of Basis and Purpose" and other supporting documentation.

TABLE I.—Analytical results of chloroform, bromoform, bromodichloromethane, and dibromochloromethane and trihalomethane in water supplies from NORS and NOMS

[Concentrations in milligrams per liter]

	NORS		NOMS		
			Phase I	Phase II	Phase III
Chloroform:					
Median.....	0.021	0.027		Dechlorinated terminal	0.044
Mean.....	—	0.043		0.059	0.022
Range.....	NF—0.311	NF—0.271	NF—0.47	NF—0.20	NF—0.069
Bromoform:					
Median.....	0.005	LD	LD	LD	LD
Mean.....	—	0.003	0.004	0.002	0.004
Range.....	NF—0.092	NF—0.039	NF—0.280	NF—0.137	NF—0.190
Dibromochloromethane:					
Median.....	0.001	LD	0.004	0.002	0.003
Mean.....	0.001	0.008	0.012	0.008	0.011
Range.....	NF—0.100	NF—0.190	NF—0.290	NF—0.114	NF—0.250

TABLE I.—Continued

NORS		NOMS			
		Phase I	Phase II	Phase III	
Bromodichloromethane:					
Median.....	0.006	0.010	0.014	0.006	0.011
Mean.....	—	0.018	0.018	0.009	0.017
Range.....	NF-0.116	NF-0.183	NF-0.180	NF-0.072	NF-0.125
Total trihalomethane (TTHM):					
Median.....	0.027	0.045	0.087	0.037	0.074
Mean.....	0.067	0.068	0.117	0.053	0.100
Range.....	NF-0.482	NF-0.457	NF-0.784	NF-0.295	NF-0.695

NF=not found.

LD=less than detection limit.

HUMAN HEALTH CONSIDERATIONS

Past use of some of the trihalomethanes, particularly chloroform and bromoform in anesthesia and medicinal preparations, respectively, has provided an extensive catalog of health effects data from high levels of human exposure.

Chloroform has been shown to be rapidly absorbed upon oral and peritoneal administration and subsequently metabolized to carbon dioxide and unidentified metabolites in urine. Chloroform is metabolized *in vitro* to 2-oxothiazolidine-4-carboxylic acid and methylene chloride. The metabolic profile of chloroform in animal species such as mice, rats, and monkeys is qualitatively similar to that in man. Trihalomethanes other than chloroform may be expected to be absorbed rapidly by ingestion and metabolized in a similar manner to chloroform in both humans and experimental animals because of their structural and chemical similarities with chloroform.

Human exposure to chloroform may result from several sources including ambient air, residues in food (from its use as a fumigant or from natural sources), toothpaste and cough medicines (until recently), and occupational exposures, as well as from drinking water. The Food and Drug Administration prohibits the use of chloroform in human drugs and cosmetics, and has proposed its prohibition in food packaging, because of the potential risk associated with its use. Depending upon the ranges of chloroform (and trihalomethanes) concentrations that have been detected in dustrialization), drinking water may contribute from none to 90 percent or more of the total daily intake.

Mammalian bioeffects following exposure to chloroform include its effects on the central nervous system, hepatotoxicity, nephrotoxicity, teratogenicity, and carcinogenicity. These responses are discernible in mammals from exposure to high levels of chloroform ranging from 30-350 mg/kg; the intensity of response was dependent upon the dose. Short term exposure to the low levels of chloroform common in air, food, and water (which are functions of location, urbanization and in-

city have been detected in some test systems. Because of the liability of organically-bound bromine, physiological chemical activity would be expected to be greater for the brominated THMs than for chloroform. For these reasons, as well as the chemical structural similarity and common route of formation, the brominated THMs are also included with chloroform in this regulation.

Epidemiological evidence relating THM concentrations or other drinking water quality factors and cancer morbidity/mortality is not conclusive, but suggestive of a health risk. Positive statistical correlations have been found in several studies, but causal relationships cannot be established on the basis of those epidemiological studies. One preliminary epidemiological study investigated the association between chloroform and TTHM and cancer mortality and obtained some positive correlations particularly with bladder cancer. The correlation was stronger for the brominated THMs than with chloroform. Several other preliminary studies have been conducted on the relationship between chlorination, sources of drinking water supplies and cancer morbidity/mortality. The evidence from these studies thus far is incomplete due to limitations in the scope of the studies, the small sample sizes, the lack of water quality data and the trends and patterns of association not having been fully developed. When viewed collectively, however, the epidemiological studies provide sufficient evidence for maintaining the hypothesis that a potential health risk may exist and that the positive statistical correlations may be due to some association with drinking water quality. More definitive studies are being conducted by EPA and the National Cancer Institute. In addition, EPA has requested the National Academy of Sciences to provide an independent assessment of those epidemiology studies already completed. Their assessment should become available in the spring of 1978.

The human health considerations are discussed in detail in the "Statement of Basis and Purpose for the Regulation of Trihalomethanes in Drinking Water", and the National Academy of Sciences Report titled "Drinking Water and Health." Although it is generally agreed that it is not possible to project with accuracy from risk estimates to absolute numbers of cancers in a human population exposed to a given agent, the approximate impact of the standard has been estimated using statistical extrapolation models derived from animal data. Statistical assessments of risk have been attempted using several mathematical models, and they indicate that the excess risk for lifetime exposure at the regulation level (0.10 mg/l)

ly found in drinking water supplies are not known to manifest acute toxic effects. The potential for human effects from chronic lifetime exposure at low concentrations is the basis for this regulation.

Evidence of the carcinogenicity of chloroform in mammals has been confirmed by several studies. These data are extensively reviewed in the report of the National Academy of Sciences titled "Drinking Water and Health" (June 1977) and in the "Statement of Basis and Purpose" incorporated by reference herein. Chloroform produced malignant and metastatic neoplasms (cancers) in at least one feeding study in mice, and has produced tumors in both rats and mice in other studies. Malignancies have been produced in a dose-related fashion in both rats and mice in the studies by the National Cancer Institute (NCI, 1976), and the latency period for the carcinogenic effect decreased as the dose increased in the male animals. Those studies established that chloroform was carcinogenic to the animals under the test conditions and therefore, might also present a carcinogenic risk to humans.

Data on the oncogenic (tumor causing) effect of other trihalomethanes are very limited, but several of them will be tested in the NCI Bioassay Screening Program. Bromoform generated excess lung tumors in preliminary pulmonary tumor induction tests with strain A mice, but chloroform did not. Brominated compounds have exhibited more carcinogenic activity than their chlorinated analogs in several cases in similar studies. Tests of the mutagenicity of a number of halogenated compounds including trihalomethanes, in the *Salmonella typhimurium* bacterial system *in vitro* have demonstrated that, in general, brominated compounds are more active than chlorinated compounds. Although chloroform was not mutagenic in that test, other trihalomethanes containing bromine and iodine were mutagenic in the bacterial test system.

Thus, although less toxicological information is available for the brominated THM's than for chloroform, toxicity, mutagenicity, and carcinogen-

would be on the order of 10^{-4} to 10^{-5} ; that is, an excess lifetime (70 year) cancer risk in the range of 1 in ten thousand to 1 in one hundred thousand. This will be reduced considerably as actual average levels below 0.10 mg/l are achieved and as the standard itself is reduced in the future. Those risk estimates are computed on the basis of chloroform alone, and do not consider the presence of other substances which might be introduced concurrently with chloroform or pollution-related contaminants and which would contribute to a higher level of risk.

CONTROL OF TRIHALOMETHANES

There are three basic ways of controlling trihalomethanes in drinking water:

1. Use of a disinfectant that does not generate trihalomethanes in water.
2. Treatment to reduce the precursor concentration prior to chlorination.
3. Treatment to reduce the trihalomethane concentration after formation.

Each of these general approaches can be further divided into other control options, depending upon individual circumstances. However, these should not be considered as mutually exclusive options. Indeed, in many cases some combination of all three may be necessary to simultaneously minimize organics and optimize pathogen control.

Since any of the disinfectants or their corresponding by-products may have some undesirable properties, a fundamental principle should be to apply whatever treatment is needed to produce water of high quality and low chemical content prior to the application of the disinfectant. Thus, the chemical disinfectant demand of the water will be minimized and pathogen control will be maintained while disinfectant use and by-product formation will be minimized.

Disinfectants other than free chlorine or hypochlorite, such as ozone, when used in conjunction with a disinfectant residual such as a chloramine or chloride dioxide, will eliminate or greatly reduce the formation of THM. Ozone in combination with a chlorine residual may be usable in some waters, although preliminary data indicate that ultimate THM precursor concentrations are not reduced.

More efficient operating control of chlorination at the treatment plant may also result in decreased trihalomethane formation. Use of a chlorine residual in a less active form such as chlorine combined with ammonia (chloramine) will significantly reduce trihalomethane formation, however, chloramines are much less potent disinfectants than free chlorine. In fact, early studies, subsequently confirmed, demonstrated that chloramines re-

quired approximately a 100-fold increase in contact time to inactivate coliform bacteria and enteric pathogens as compared to free available chlorine. For this reason, chloramines are not recommended for use as primary disinfectants in drinking water treatment. Chloramine treatment finds its widest application in maintenance of chlorine residuals in the distribution systems, after primary disinfection with free available chlorine or other disinfectant. The health effects of water treatment with chloramine have not been studied in detail. Although these disinfectants in the absence of chlorine do not produce trihalomethanes, questions have been raised on the issue of the toxicology of chlorine dioxide and other disinfectants and their byproducts. Chlorine dioxide introduces chlorite ion upon partial reduction.

Studies with cats have shown that chlorite has a deleterious effect on red blood cell survival rate at chlorine dioxide concentrations above 10 mg/l. Therefore, a limit of 1.0 mg/l is necessary to prevent potential adverse effects on sensitive individuals, particularly children. Additional studies are underway to clarify this matter.

The Administrator is authorized to restrict the use of alternative disinfectants such as chloramines and chlorine dioxide under Section 1401(1)(D) of the Act which provides that in addition to a maximum contaminant level, a Primary Drinking Water Regulation must include "criteria and procedures to assure a supply of drinking water which dependably complies with such maximum contaminant levels; including quality control and testing procedures to insure compliance with such levels and to insure proper operation and maintenance of the system * * * Congress anticipated that additional safeguards would be necessary to assure that public water systems dependably supply safe drinking water (see House Report at p. 13). While the Administrator is prohibited by Section 1412(b)(6) of the Act from requiring the addition of any substance for preventive health care purposes, he is not precluded from restricting the use of chemicals which he finds might jeopardize the provision of a safe supply of drinking water.

Because the establishment of an MCL for trihalomethanes attributable to chlorination practices will cause many water suppliers to turn to alternative disinfectants which are either less effective than chlorine or have undesirable side-effects of their own, it is necessary to restrict the use of such alternatives in order to assure that the most healthful drinking water is being provided to consumers while efforts are being made to comply with the specific MCL requirements for THM and microbiological contaminants.

High Total Organic Carbon (TOC) levels in water can be indicators of potentially high disinfectant demand because of consumptive chemical processes (e.g. THM production from chlorine). Ozonation of high TOC waters can also lead to aftergrowth of flora in distribution systems. Thus, particular care must be taken in the selection of the total treatment scheme, especially in waters with TOC concentrations above approximately 2 mg/l, to avoid the potential problems that can be introduced by excessive application of any disinfectant.

The trihalomethanes precursors, which are probably complex mixtures of humic and fulvic substances and may also include simpler low molecular weight compounds containing the acetyl group ($\text{CH}_3\text{—C=O}$), can be reduced to some degree by effective coagulation and filtration. The maximum benefit from this technique for precursor removal is not achieved unless the chlorine is added only at that point in the treatment process where precursor concentration is lowest (i.e. after coagulation and settling or after filtration).

Use of fresh granular activated carbon (GAC) is the best technique among all of the control options because it is effective both for precursor and trihalomethane removal (to a lesser degree) as well as for general removal of contaminating organic chemicals. The versatility of GAC application for general organic chemical removal is important because Revised National Primary Drinking Water Regulations, to be based on the recent National Academy of Sciences Report, "Drinking Water and Health," will contain MCL's or treatment techniques for additional organic chemicals. Thus the use of GAC for THM control could obviate the need for additional treatment modifications to control other contaminants and to provide added protection from other undesirable organic chemicals such as from upstream pollution. Thus, EPA recommends that public water systems drawing water from sources subject to contamination with synthetic organic chemicals should use adsorbents like GAC in their treatment processes in order to provide the best level of protection of the public health from organic chemical contamination. This is consistent with the accompanying proposed treatment regulation for synthetic organic chemicals.

Some operational problems with GAC use include its relatively short life for THM control in some waters and bacterial growth on the adsorbents. In some water treatment procedures, in German practice, biological activity on the GAC, "biological activated carbon (BAC)," is encouraged as an effective means of reducing organic chemical loadings and extending the

time between reactivation of the carbon. A typical treatment train utilizing the BAC approach might include raw water chlorination and coagulation followed by ozonation, contact with deep beds of granular carbon, then application of a disinfectant such as chlorine dioxide for maintenance of a residual. EPA encourages the use of adsorbents such as GAC where appropriate to reduce THM precursors as well as other contaminants and our research program is actively studying all aspects of its application.

Two techniques have been tested for removal of THM from water after formation. These include aeration with a high gas-to-water ratio and the use of an adsorbent specifically designed for THM removal. Neither of these techniques would alter the continued generation of THM in the distribution system from the reaction of remaining precursors and a free chlorine residual.

The NORS and NOMS studies have shown some degree of correlation between concentrations of trihalomethanes and Non-Purgeable Total Organic Carbon (NPTOC) measurements on finished water. NPTOC and TOC measurements can now be made readily and at low cost per sample. Thus TOC or NPTOC analyses conducted along with the THM monitoring might provide some insights to the water system operators as to water quality factors influencing THM formation. NPTOC or TOC measurements might ultimately be useful for predicting THM formation potential in a water system using a particular treatment method.

Discussions of the various treatment techniques in detail, including the estimated cost of treatment, specific suggestions for modifications of several different types of water treatment plants, and recommendations for operational monitoring, as well as of NPTOC analyses are contained in the "Interim Treatment Guide for the Control of Chloroform and other Trihalomethanes" and the "Economic Impact Analysis of a Trihalomethane Regulation for Drinking Water." In addition EPA is funding an investigation of the worldwide use of ozone, chlorine dioxide and "biological activated carbon," to include operating experiences, engineering details, design criteria and economics. This report, being developed by Public Technology Inc., will be available in early 1978.

REGULATORY APPROACH

The Safe Drinking Water Act mandates that substances in drinking water that may have adverse human health effects should be controlled to the extent feasible using available technology and taking costs and other factors into consideration. In the Interim Primary Drinking Water Regulations promulgated December 24,

1975, 40 CFR at 5956B, the Administrator stated that as soon as sufficient information was developed from the monitoring programs and related research, the regulations would be amended to deal with additional organic chemicals beyond the six pesticides regulated at that time. The Administrator has now determined that a maximum contaminant level for chloroform and related trihalomethanes under the Interim Primary Regulations is warranted and that means are available to larger water systems to control trihalomethanes without increasing the risk of microbiological contamination. This decision was reached based on the following factors:

1. The health effects data, including bioassay, monitoring, mutagenicity, and epidemiology are further developed for chloroform and by implication for THMs than for other organic chemicals in drinking water.

2. THMs are generally present in greater concentrations than other organic chemicals in drinking water, thus facilitating feasible monitoring and analytical techniques.

3. THMs are more ubiquitous contaminants of drinking water than other synthetic organic chemicals.

4. Several treatment procedures are available for THM control in drinking water.

The decision process also included the responses to the ANPRM and the concurrence of the National Drinking Water Advisory Council.

These regulations should not be construed as compromising the absolute principle of providing drinking water of the highest microbiological quality, or of discouraging the use of chlorine (or hypochlorite), but rather as encouraging application of the most effective treatments under optimal conditions so as to minimize formation of undesirable by-products, be they organic or inorganic. This philosophy encourages selection of the best available raw water source and application of the most appropriate physical and chemical processes to produce water of very high quality (and low disinfectant demand) prior to application of the disinfectant. This amendment to the Interim Regulations will initially affect those situations where excessive quantities of trihalomethanes are being generated by current treatment practices. In addition, the techniques that will be utilized to reduce trihalomethane concentrations will also concurrently result in reductions of many other contaminants that are undesirable by-products of the treatment process or are contaminants in raw water.

The causes and incidences of waterborne disease outbreaks demonstrate the essentiality of water disinfection and the continued use of chlorine. Except for the demonstrated public

health benefits of chlorination, trihalomethane concentrations might have been controlled at a lower level sooner. At least in the near term, chlorination must be continued to prevent infectious waterborne disease and thus at this time THM concentrations are being reduced by technologically and economically feasible methods rather than being eliminated. The NAS report, "Drinking Water and Health," articulated principles which were generally utilized in the rationale for these regulations:

1. Effects in animals, properly qualified, are applicable to man.

2. Methods do not now exist to establish a threshold for long-term effects of toxic agents.

3. Exposure of experimental animals to toxic agents in high doses is a necessary and valid method of discovering possible carcinogenic hazards in man.

4. Material should be assessed in terms of human risk, rather than as "safe" or "unsafe."

Thus the proposed MCL of 0.10 mg/l should not be construed as a "safe" level. The current scientific thought on human exposure to substances which have been demonstrated to be carcinogens in animals in appropriate tests is that they be considered potential carcinogenic risks to humans. The presumption is that health risk is related to the extent of exposure and that no threshold exposure level without risk can be demonstrated for a genetically diverse population. Thus, translated into a regulatory philosophy, exposure to those substances should be minimized so as to minimize risks. Therefore, water systems should strive to reduce THM concentrations to levels as low as is economically and technologically feasible, without compromising the microbiological quality of the drinking water.

Based upon these considerations, an MCL of 0.10 mg/l for THM has been proposed under interim regulations as a reasonable level providing health protection to the extent feasible. This should not lead to complacency on the part of systems with a THM of 0.09 mg/l for example, but should be construed only as a starting point which will, over time, be lowered progressively as technologic, economic, and practical constraints permit. Within 2 years after the effective date of this regulation, EPA will review the implementation experience. Assuming successful implementation, it is expected that the MCL will be reduced and/or coverage of impacted public water systems will be expanded to include additional smaller systems. As soon as sufficient practical experience has been gained so as to optimize the application of these or other technologies, EPA expects that levels as low as 0.010 mg/l or less will be attainable in many cases.

Selection of a Maximum Contaminant Level of 0.10 mg/l for THM was based on a balancing of public health considerations and feasibility of achievement. This included such practical considerations as availability of control technology, monitoring methods and trained personnel, economic considerations, new risks which may be introduced from changes in current treatment practice and the resource-limited technical assistance available from EPA. Establishment of a specific MCL is therefore not a license for those systems with lower THM levels to allow concentrations to increase to the MCL. Rather, all water systems should strive to minimize THM concentrations by technologically and economically feasible methods that will not compromise protection from waterborne infectious disease. EPA expects that application of the various control possibilities will probably result in many water systems achieving levels well below the MCL.

Analogous to the use of the coliform test as a simple indicator of the presence of microbial pathogens in water, THM concentrations should be treated as indicators of the presence of other undefined halogenated compounds concurrently produced during chlorination. Thus, measures that are taken to reduce THM concentrations will concurrently provide the additional benefit of reducing human exposure to the other undefined by-products.

Because of the structural, and likely biochemical and toxicological similarities of the trihalomethanes, and their common occurrence in drinking water in much higher quantities than other synthetic chemicals, and because the exposed human population is very large, EPA has determined that an MCL for trihalomethanes should be part of the first phase in its approach to synthetic organic chemical control in drinking water. Pollution-related contaminants will be more comprehensively controlled, in the concurrent proposed treatment regulations for synthetic organics and in the Revised National Primary Drinking Water Regulations.

SELECTION AND APPLICABILITY OF THE MCL

This part of the amended interim regulations is the first step in a phased regulatory approach to controlling potentially harmful organic chemicals in drinking water. This part consists of a Maximum Contaminant Level for total trihalomethanes and of monitoring requirements that apply to community water systems in a manner that is dependent upon population served, as follows:

1. Systems serving populations greater than 75,000 persons—MCL for total trihalomethanes at 0.10 mg/l would be effective 18 months from the date of promulgation of

the regulations. Monitoring at a minimum of 5 analyses per quarter would be effective 3 months from the date of promulgation of the regulations. Standard Plate Count analyses are required to ensure maintenance of microbiological quality when treatment changes are implemented and is also effective 3 months after promulgation.

2. Systems serving populations between 10,000 and 75,000 persons—the MCL is not applicable. Monitoring for one year at a minimum of 2 analyses per quarter effective 6 months from the date of promulgation of the regulation would be required. These results must be periodically reported to the responsible State agency and EPA.

3. Systems serving populations smaller than 10,000 persons are not subject to the MCL for THM or monitoring requirements at this time.

The selection of an MCL, monitoring requirements and population coverage in these interim regulations was based upon the feasibility of achieving reductions of THM's and the concern that any attempted modification of disinfection practice to control trihalomethanes must not in any way affect the microbiological quality of drinking water which would increase the possibility of transmission of infectious disease.

The interim MCL of 0.10 mg/l total trihalomethanes was selected from a number of higher and lower options that were considered. Available control and monitoring technology, national and per capita costs, population coverage, and availability of personnel, equipment and materials were among the feasibility factors influencing the decision. The mean levels of THMs from Phase II and Phase III of the National Organics Monitoring Survey (NOMS, Table 1) were 0.117 mg/l and 0.100 mg/l, respectively, in water samples that were allowed to react to completion. Averages between dechlorinated and terminal samples could be considered as estimates representative of likely concentrations to be found at the tap of the average consumer. These were 0.093 mg/l in Phase II and 0.077 mg/l in Phase III. Maximum THM levels ranged as high as 0.695 mg/l and 0.784 mg/l in terminal samples. Therefore, an interim MCL of 0.10 mg/l, will result in substantial reduction of THM concentrations in many water systems now exceeding the MCL and provide adequate health protection.

The MCL and its associated monitoring requirements apply to community water systems serving populations greater than 75,000 persons. Water systems serving between 10,000 and 75,000 persons are required only to monitor for trihalomethanes and report the results to EPA and the State. There are 390 community water systems in the United States serving populations greater than 75,000 persons and they represent a total population of 100 million persons, or 52 percent of the total population served

by community water systems. Initial limitations of the MCL to systems serving populations greater than 75,000 provides an achievable level of protection and introduces a manageable demand on the supplier industries for instrumentation, raw materials, construction, activated carbon and disinfectants, and expert personnel. Control is thus technologically and economically feasible in that size range. The 2,300 community water systems serving populations between 10,000 and 75,000 persons represent a total population of 62 million persons or 32 percent of the total population served by community water systems. In these communities reasonable steps to minimize THM concentrations should be evaluated and utilized where feasible under proper supervision. EPA feels that requiring water systems serving populations between 25 and 10,000 persons to meet the MCL or monitoring requirements would not be feasible at this time in most instances, and it encourages their continued use of chlorine and other necessary disinfection treatment methods while additional information is being generated by the first phase of this regulatory program.

A considerable level of protection is provided by this regulation since it applies to those locations where the likelihood of THM contamination is greatest. The great majority of larger public water systems that are covered by those regulations utilize surface water which is more likely to produce greater quantities of trihalomethanes. The majority of small systems utilize groundwater, a less likely source of trihalomethanes. In addition, many of the small systems do not now chlorinate and therefore would not be producing THMs.

The almost 40,000 public water systems in the United States ranging in size from 25 to several million persons serve water to almost 200 million people in total. Because of the intimate relation of THM control to the disinfection process and the limited THM control technology experience in the United States, EPA feels it is imperative that any changes in current treatment practice must be carefully supervised and supported by technical assistance from the States and EPA.

Both EPA and State resources for this type of technical assistance are very limited. In a number of cases the changes in treatment practice attendant to this regulation will involve application of fairly sophisticated new procedures involving close cooperation of engineers, chemists and microbiologists to assure successful treatment without sacrificing microbiological quality of drinking water. It is not prudent nor feasible therefore to deal with all public water systems in the short term. Rather, EPA chose as an initial

step to select an MCL for THM that would be protective and to limit its application to a large but reasonable number of public water systems that would have the financial base and access to expertise necessary to achieve that MCL.

Using a phased regulatory approach, EPA intends to initially affect the public water systems serving the largest populations and the worst cases of high level exposure to THM. In the future, as additional experience is gained, the MCL for THMs will become more restrictive and coverage will be extended to smaller water systems as necessary to adequately protect the public health. At this time, while EPA believes that exposure of consumers of drinking water to THM's should be reduced to the extent feasible, no less health protection is necessarily being provided to those smaller public water systems not covered by the MCL, many of which utilize ground water. Because THM levels are not expected to be high for ground water sources of drinking water, smaller water systems are being required to monitor for the presence of THMs in order to better ascertain the scope of the problem in that size category. EPA believes that it is consistent with the Act's objective of health protection to proceed with care in controlling THM's in light of the delicate balance between THM reduction and adequate disinfection.

A number of community water systems which are not now impacted by this regulation presumably will either voluntarily or due to State action also attempt to reduce THM concentrations. While such action is encouraged, EPA recommends that this be attempted only under appropriate State supervision, and the Agency will provide technical assistance to such efforts within available resources.

THM MONITORING REQUIREMENTS

THM monitoring pursuant to Section 1445(a) in systems larger than 75,000 persons should be performed at least quarterly, and a minimum of 5 samples should be collected on the same day and analyzed according to EPA approved procedures, and the results arithmetically averaged. Initial sampling must begin within 3 months of promulgation of these amendments so that data will be available in time for systems to determine corrective actions before the effective date of the regulation. The sampling locations should be selected to be representative of the THM concentrations at the consumers' taps. No more than 20 percent of the samples should be collected at the entry point of the distribution system and no less than 20 percent should be at extremes in the system. The remaining 60 percent should be from locations representative of popu-

lation density throughout the distribution system.

Compliance with the MCL is computed by averaging the quarterly values from the preceding 12 months. This method was selected, rather than basing compliance on the highest value obtained in any single sample, because of the large and possibly uncontrollable variations of raw and finished water quality that occur in the short term. These and other factors which must be dealt with on a case-by-case basis could lead to wide variations of THM concentrations. At this time it would be unreasonable to demand the kind of pinpoint control that would be necessary to maintain THM levels below a particular figure at all times and at all locations in the distribution system of every water system. This approach could be changed as additional experience is gained through the implementation of this regulation.

Monitoring for THMs in smaller systems (10,000 to 75,000 persons) pursuant to Section 1445(a) of the Safe Drinking Water Act should be initiated within 6 months of promulgation of these amendments and should continue for a period of one year. These data will assist EPA in assessing the magnitude of THM concentrations in these systems and in making determinations as to the need and feasibility of revised regulations in that size category. In addition, identification of locations with high THM levels will allow the system, State or EPA to take appropriate action on a case-by-case basis when feasible. Monitoring requirements are minimal, involving only 2 analyses per quarter. Both samples should be collected at the entry to the distribution system at the same time. One sample should be dechlorinated immediately; the other sample should be dechlorinated and should be stored for 7 days in the sample container at room temperature (20° to 25° C) prior to analysis to permit the chlorination reactions to go to completion. The results from the two samples should thus reflect the extremes of possible THM concentrations in the drinking water. These data must be reported to EPA and the State. Data from the 1976-1977 NOMS has been transmitted to each of the 113 participating water systems, so a number of them already have sufficient information in hand from which to plan compliance needs. To assure that sufficient qualified laboratories will be available to perform the required analyses, EPA is developing a Quality Assurance program and will expand the current laboratory certification program. This will assure the validity of the analytical data used by water systems to determine compliance and possible treatment modifications.

ADDITIONAL MICROBIOLOGICAL MONITORING REQUIREMENTS

To assure that any steps taken to reduce THM concentrations in drinking water will not increase the possibility of microbial contamination, additional microbiological monitoring is required for a water system that is modifying existing treatment practice. Standard Plate Count (SPC) determinations must be made at least daily both at the treatment plant and in the distribution system, for one month before and six months subsequent to the treatment change to assure that no degradation of water quality occurs. Analyses prior to the change are intended to provide a baseline to which subsequent effects can be compared. The appropriate number and sampling locations of SPC analysis should be determined by the State or EPA depending on local conditions. Significant deviations from the "normal" range must be reported to the State or EPA and corrective actions taken immediately.

The normal microbiological organisms in public water supplies originate from the source water. This initial population of bacteria may be drastically reduced through chemical treatment and filtration. Disinfection will further reduce the remaining population significantly to perhaps one ten thousandth of the bacterial population in the source water. These survivors may be joined by other organisms that penetrate the treatment barrier along with turbidity or during momentary lapses in treatment. Microbial contaminants carried by airborne dust introduced through clear well vents, installation and repair of distribution lines, cross-connections, and negative line pressure situations all contribute to a microbial population that is partially enumerated by the Standard Plate Count.

Water treatment regimes are designed to minimize the public health risk associated with organisms of sanitary significance, but the process becomes selective of certain microbial strains. Although the genera of organisms detected by the Standard Plate Count may not be harmful or dangerous to normal persons when present in drinking water in low numbers, under certain conditions, these organisms are known to produce severe or chronic human infections. The National Academy of Science Report "Drinking Water and Health" underscores the usefulness of the Standard Plate Count in evaluating these organisms and recognizes that the Standard Plate Count should be used in conjunction with the total coliform procedure(s) to measure the sanitary quality of potable water. In that report, the Academy recommends use of the Standard Plate Count to:

1. Provide a method of monitoring for changes in the microbiological quality of finished water,

2. Determine whether the normal flora of a water supply may be interfering with coliform detection, and,

3. Monitor the effectiveness of a disinfectant or treatment practice within the plant and distribution system and provide an indication of filter-effluent quality deterioration and the occurrence of the positive breakthrough of pathogenic microorganisms.

Use of the Standard Plate Count in evaluating disinfectant efficiency should be coupled with total coliform determinations at various plants in the treatment process. This information will provide an indication of relative efficiency of each treatment process so that when changes are made, any deterioration of water quality can be detected. It should be clearly understood that the Standard Plate Count is not a substitute for total coliform as a measurement of the sanitary significance of potable water, but rather a sensitive tool to signal an increased potential risk of breakthrough of undetected pathogens such as viruses or protozoa.

The presence of coliform bacteria in water is still considered the most reliable indicator of possible fecal contamination and any associated enteric pathogenic microorganisms. Certain viruses and the cysts of *Entamoeba histolytica* and *Giardia lamblia*, however, are capable of surviving in water for longer periods of time than the indicator coliform bacteria. In addition, these pathogenic organisms are also somewhat more resistant to disinfection than the indicators.

Thus, use of the Standard Plate Count at least during periods of treatment alteration will provide a more sensitive indication of any changes in the effectiveness of microbial control resulting from process changes.

STATE DISCRETION FOR MONITORING FREQUENCIES

The State is granted discretion to adjust monitoring requirements after one year upon a determination that local conditions are such that THM concentrations would not be likely to approach or exceed the MCL. After THM data have been collected according to the requirements for a full year, a community water system may request that the State allow a reduction of the monitoring frequency. The State's case-by-case decision should be based on such factors as the monitoring data, the quality and source of the raw water, and the type of treatment employed. Monitoring cannot be reduced to less than one sampling every six months. After the first year's monitoring data have been obtained this minimal additional monitoring should be sufficient to demonstrate that conditions have not changed to the extent that the water supply might later exceed the MCL. However, a change in the source of water or

modification of the treatment program would require that the initial monitoring requirement be reinstated to reestablish the baseline.

EFFECTIVE DATES OF MONITORING REQUIREMENTS

The regulations would require that baseline quarterly monitoring for THM's for the larger systems (about 75,000 persons and above) would be initiated within 3 months of promulgation of these amendments, and for smaller systems (about 10,000 to 75,000 persons) within 6 months of the date of promulgation.

The effective date for the TTHM Maximum Contaminant Level would then be 18 months after the promulgation date. This schedule is proposed so that sufficient time will be available to the affected Public Water Systems for the acquisition of equipment and personnel, the accumulation of baseline compliance data, conducting of engineering feasibility studies and the introduction of control technology. In addition, 18 months is deemed sufficient time for States with primary enforcement responsibility to incorporate the new Federal requirements into their statutory and/or regulatory authorities.

ECONOMIC IMPACT OF THM REGULATIONS

The economic impact was projected based on several control options available to satisfy the regulatory requirements—modifying chlorination or other treatment procedures, changing disinfectants, or using an adsorbent. The calculation of cost projections for the THM regulation requires an estimation of the number of systems which are likely to select each of these treatment strategies to comply with the regulation. An incremental cost will accrue to all systems impacted, whether or not treatment is required, to cover monitoring expenses. Because no empirical method exists for predetermining the choice of treatment that would be made by each affected public water system, a more probabilistic and structured approach was used. A logical sequence of decision points was designed to distribute the systems covered by the regulation according to the most likely path they would follow. The decision made at each point is consistent with certain criteria as follows:

1. The treatments currently used: If a system does not add chlorine it will not be affected by a THM regulation, and therefore will require no new treatment.

2. Water source used: If a system uses surface water (except the Great Lakes and some high quality mountain waters) as its primary source, it is more likely to exceed a given level of THM contamination. Hence, the number of water systems using water from ground or surface sources affects the

number of systems which will exceed the MCL and therefore require treatment.

3. Degree to which water quality exceeds MCL: If the presence of THM is only slightly in excess of the initial MCL, then minimal modifications to procedures may be adequate for compliance. As the level of contamination increases, a system must consider more significant (and costly) treatment techniques.

4. Economic considerations: The presumption was that systems would adopt the least costly treatment strategy that satisfies the regulations.

5. Treatment effectiveness: The presence of THMs above certain levels can probably be best controlled by the use of adsorbents. This is because of the likelihood that high disinfectant demand waters cannot be disinfected adequately without generating considerable amounts of by-products of unknown hazard. Consequently, those systems with very high levels of THMs are likely to use adsorbents.

Of the 390 public water systems that serve more than 75,000 people, 60 purchase the majority of their water from other systems that are presumed to provide treatment. Thus a total of 330 systems would be initially affected, although 18 of these are excluded because they do not presently add chlorine. Of the remaining 312, some 86 were estimated to have TTHM levels above 0.10 mg/l and hence would require treatment changes.

The 21 systems estimated to exceed the level by less than 25 percent were assumed to be able to comply by the least costly method; modifying current chlorination or other procedures. The remaining 65 systems are split into those above and below 0.25 mg/l of TTHM. Of those estimated to be over the 0.25 mg/l level, 20 percent were assumed to be able to comply by changing disinfectant and 80 percent would probably use an adsorbent to achieve compliance, because changing disinfectants alone might not be an appropriate method to bring the systems into compliance with the regulation considering the quantity of other by-products that might be formed. Eighty percent of those between 0.125 and 0.25 mg/l were estimated to change disinfectant and the remaining 20 percent would also use an adsorbent. On the basis of the above assumptions, national cost, exclusive of monitoring costs, for compliance with the proposed regulations are as follows:

SUMMARY OF ESTIMATED TOTAL COSTS FOR AN MCL REGULATION FOR TRIHALOMETHANE CONCENTRATION OF 0.10 MG/L

[In millions of 1976 dollars]

Capital expenditures, cumulative to 1981.....	154.4.
External financing, cumulative to 1981.....	145.2.
Operating and maintenance expenses, 1981.....	25.9/yr.
Revenue requirements, 1981.....	36.0/yr.
Annual per capita costs* (dollars).....	2.07/person.

*Revenue requirements divided by population served by the cost-impacted systems

Per capita costs vary depending upon the type of treatment selected,

population and other factors and range from 28 to 93 cents for alternate disinfectants and \$3.30 to \$6.11 for an adsorbent assuming a 60 day regeneration cycle. Detailed analyses of costs of the options are contained in the "Economic Impact Analysis of a Trihalomethane Regulation for Drinking Water", available on request.

Monitoring costs were computed based upon a survey of contract analytical laboratories currently performing TTHM analyses. Per sample costs ranged from 25 dollars to 100 dollars. After these regulations have been promulgated, the increased volume of business and competitive factors would be expected to reduce the analytical costs to below 25 dollars per sample.

Annual monitoring costs for a large community water system (greater than 75,000 population), assuming the minimum frequency of 5 samples per quarter and 25 dollars per sample, amount to \$500. Annual costs for a smaller water system (10,000 to 75,000 population) at the minimum frequency of 2 per quarter amount to \$200. Annual national monitoring costs amount to \$153,500 for the 307 out of 390 (less 18 that do not chlorinate) large systems that probably would not need to alter their current treatment practice and \$464,000 for the approximately 2300 smaller systems affected.

EPA expects that a number of community water systems will choose to purchase the equipment and monitor for THM on-site more frequently than the minimum, for operational control as well as for compliance purposes. An additional benefit from purchase and on-site analytical capability, is that the gas chromatograph is versatile and can be used to monitor for the presence of many other organic chemical contaminants besides THMs. The cost of equipping an existing laboratory with an appropriate gas chromatograph is dependent upon which analytical procedure is selected and the type of instrument. The basic instrumentation for the "liquid-liquid" extraction method consists of a gas chromatograph with an "Electron Capture" detector and recorder; cost approximately \$5,000. The basic instrumentation for the "purge and trap" method consists of a gas chromatograph, a halogen-specific detector "purge and trap" sample concentrator, and recorder; cost approximately \$10,000. In either case, additional expenditures for accessories should be added. Costs would also be greater for more sophisticated instrumentation beyond the basic system.

EPA is concurrently conducting studies on analytical methods based on gas chromatography alone that would be feasible for direct monitoring and operational use by public water system personnel. This project titled the National Screening Program for

Organic Chemicals, is attempting to develop methodology and demonstrate applicability in several hundred public water systems.

PART II. SYNTHETIC ORGANIC CHEMICALS

A large number of synthetic organic chemicals have been identified in various drinking water supplies in the United States. Since these chemicals are normally present in only very small quantities, it has only been within the past few years that sufficiently sensitive analytical methods have been developed to detect and quantify such chemicals at low levels. As analytical techniques become more sensitive and as new techniques are developed, the number of chemicals detected continues to grow.

These chemicals have been found for the most part in surface water supplies which have become the repository for the waste discharges of numerous industrial facilities and municipalities as well as for urban and agricultural runoff. Groundwater supplies, however, have not been spared from contamination due to the leaching of these chemicals from poor maintenance practices at industrial facilities and improper on-land disposal of wastes.

At the time of the passage of the Safe Drinking Water Act in 1974, there were more than 12,000 chemical compounds known to be in commercial use, and many new chemical compounds are being added to the list each year.

The causes of synthetic organic chemical contamination are both chronic and variable in nature. Industrial discharges from point sources are regulated by this Agency under the Federal Water Pollution Control Act's National Permit Discharge Elimination System. However, despite the control of industrial discharges through a comprehensive nation-wide permit system, a certain amount of toxic pollutants continues to be discharged into surface waters. In addition, there is always the possibility of accidental spills. A large quantity of chemicals may thus enter a water supply system against which current water treatment practices are not presently equipped to provide protection. Finally, there are an undefinable number of non-point sources of pollution which contribute to the problem. Many pesticides used for agricultural purposes are known to be highly toxic. Stormwater runoff carrying other potentially harmful toxic chemicals is another pollution-related source of contamination. EPA has conducted several surveys since the passage of the Safe Drinking Water Act in an effort to assess the occurrence of synthetic organic chemicals in the nation's drinking water supplies. The National Organics Recon-

naissance Survey (NORS) conducted in 1974-1975 detected as many as 129 organic compounds in finished water supplies throughout the country. Synthetic organic chemicals that were found included carbon tetrachloride and 1,2-dichloroethane.

The most recent comprehensive data on the occurrence of synthetic organic chemicals in drinking water is from EPA's National Organics Monitoring Survey (NOMS) conducted under the National Interim Primary Drinking Water Regulations. The synthetic organic chemicals identified encompass many of the known classes of compounds including halogenated aliphatic and aromatic hydrocarbons such as carbon tetrachloride, dichloroethane, vinyl chloride, and chlorobenzenes; pesticides such as dieldrin and lindane; aromatics such as benzene, toluene and styrene; polynuclear aromatics such as fluoranthene; nitrogenous compounds such as aniline and nitrobenzene; esters such as dibutylphthalate; and many others. The three compounds most frequently found at average concentration levels in the low parts per billion range were pentachlorophenol, dichlorobenzene and trichloroethylene. The data from the NOMS is discussed in greater detail in the Statement of Basis and Purpose which is incorporated by reference herein.

This and other occurrence data clearly demonstrate that synthetic organic chemical contamination in many of the nation's drinking water supplies is a reality. As part of the Agency's pronounced objective to reduce the public's exposure to toxic chemicals in the environment generally, this proposed regulatory action to reduce the levels of such chemicals in the nation's drinking water supplies to the maximum extent feasible was deemed necessary at the present time.

HUMAN HEALTH CONSIDERATIONS

Synthetic organic chemical contaminants have been found to cause both acute and chronic adverse effects in humans at high exposure levels. However, at the lower concentrations at which they occur in drinking water, EPA's primary concern is with their potential contribution to elevated cancer risks. At the present time, the specific cause(s) of cancer is not yet understood. Nevertheless, there is growing agreement within the scientific community that prolonged exposure to carcinogenic contaminants in the environment, including food, air and water, contributes significantly to the incidence of this dread disease which accounts for approximately 350,000 deaths annually in the United States. Other long-term risks such as mutagenicity and teratogenicity are also of serious concern.

Thus, EPA as well as other federal agencies such as the Food and Drug

Administration, the Occupational Safety and Health Administration and the Consumer Product Safety Commission, and other public health institutions around the world have adopted policies of limiting human exposure to carcinogens to the maximum extent feasible. This policy is clearly consistent with the protective philosophy of the Safe Drinking Water Act and forms the basis for EPA's proposed action to reduce the level of synthetic organic chemicals in drinking water through the prescription of a treatment technique.

Although the concentrations of each synthetic organic compound, when detected in drinking water, have been generally at the parts per billion level or lower, the aggregate exposure to such chemicals from a lifetime of water consumption is significant in terms of potential risk to human health. Moreover, EPA data on the occurrence of such chemicals in drinking water indicate that unique exposure to one or a few of these compounds is never the case. Thus, there is the possibility of synergistic interactions among chemicals thereby enhancing the associated risks.

Our ability to assess the effects of synthetic organic chemicals on man is primarily based on animal tests which necessarily use higher levels of exposure than those encountered in the environment.

Toxicological studies with animals are the best available means of predicting hazards to humans from exposure to toxic substances. Additionally, in some cases, direct evidence of human cancer attributable to chemical exposure has been obtained, particularly in the working environment. EPA's concern about increased cancer risk associated with some of the organic substances in drinking water is thus primarily related to those compounds which have been classified as carcinogens based on animal studies. This concern has been increased by the results of a number of recent preliminary epidemiological studies, which suggest a statistically significant association between drinking water quality and cancer. The toxicological and epidemiological studies are discussed in greater detail in the Statement of Basis and Purpose incorporated by reference herein.

In a recent report funded by EPA and conducted by the National Academy of Sciences (NAS) entitled "Drinking Water and Health," the NAS identified 22 known or suspected carcinogens which have been found in some drinking water. They also discussed the issue of assessment of human health risks associated with exposure to chemicals in the environment and drew several conclusions:

PRINCIPLE 1

Effects in animals, properly qualified, are applicable to man. This prem-

ise underlies all of experimental biology and medicine. But, because it is continually questioned with regard to human cancer, it is desirable to point out that cancer in men and animals is strikingly similar. Virtually every form of human cancer has an experimental counterpart; and every form of multicellular organisms is subject to cancer, including insects, fish, and plants. Although there are differences in susceptibility between different animal species, between different strains of the same species, and between individuals of the same strain, carcinogenic chemicals will affect most test species; also large bodies of experimental data indicate that many chemicals that are carcinogenic to animals are likely to be carcinogenic to man, and vice versa.

PRINCIPLE 2

Methods do not now exist to establish a threshold for long-term effects of toxic agents. With respect to carcinogenesis, it seems plausible at first thought, and it has often been argued, that a threshold must exist, below which even the most toxic substance would be harmless. Unfortunately, a threshold cannot be established experimentally that can be applied to a total population. A time-honored practice of classical toxicology is to establish maximal tolerated (no-effect) doses in humans on the basis of finding a no-observed-adverse-effect dose in chronic experiments in animals and to divide this dose by a "safety factor" of say, 100, to designate a "safe" dose in humans. There is no scientific basis for such estimations of safe doses in connection with carcinogenic effects.

Experimental bioassays in which even relatively large numbers of animals are used are likely to detect only strong carcinogens. Even when negative results are obtained in such bioassays, it is not certain that the agent tested is unequivocally safe for man. Therefore, we must accept and use possibly fallible measures of estimating hazard to man.

PRINCIPLE 3

The exposure of experimental animals to toxic agents in high doses is a necessary and valid method of discovering possible carcinogenic hazard in man. The most commonly expressed objection to regulatory decisions based on carcinogenesis observed in animal experiments is that the high dosages to which animals are exposed have no relevance in assessment of human risks. It is therefore important to clarify this crucial issue.

Practical considerations in the design of experimental model systems require that the number of animals used in experiments of long-term exposure to toxic materials will always be small compared with the size of the human populations similarly at risk.

To obtain statistically valid results from such small groups of animals requires the use of relatively large doses so that the effect will occur frequently enough to be detected. For example, an incidence as low as 0.01 percent would represent 20,000 people in a population of 200 million and would be considered unacceptably high, even if benefits were sizable. To detect such a low incidence in experimental animals directly would require hundreds of thousands of animals. For this reason, we have no choice but to give large doses to relatively small experimental groups and then to use biologically "reasonable" models in extrapolating the results to estimate risk at low doses. Several methods for making such calculations have been considered and used, but we think that the best method available to us today is to assume that there is no threshold and that a direct proportionality exists between the size of the dose and the incidence of tumors. However, it is important to recognize that such a calculation may give either too small or too large an estimate of risk. The actual risk to humans might be even greater over a human lifetime, because it is about 35 times that of a mouse; and there is evidence that the risk of cancer increases rapidly with the length of exposure. Moreover, experimental assays are conducted under controlled dietary and environmental conditions with genetically homogeneous animals, whereas humans live under diverse conditions, are genetically heterogeneous, and are likely to include subpopulations of unusual susceptibility.

PRINCIPLE 4

Material should be assessed in terms of human risk, rather than as "safe" or "unsafe." The limitations of the current experimental techniques do not allow us to establish safe doses, but with the help of statistical methods we may be able to estimate an upper limit of the risk to human populations. To calculate such a risk we need data to estimate population exposure; a valid, accurate, precise, and reproducible assay procedure in animals; and appropriate statistical methods.

These principles reaffirmed EPA's reliance on data based on animal testing at high dosage levels as a reasonable basis for assessing potential human carcinogenic effects and its conclusion that no "safe" or "unsafe" level for such contaminants can be identified with existing scientific techniques. NAS suggested that the risk could be approximated with available extrapolation techniques and, applying such techniques, derived risk estimates for the identified carcinogens.

As with most pathways of exposure to cancer-causing agents in the environment, there is no direct evidence

that consumption of drinking water has actually caused human cancers. However, EPA believes that such carcinogens when present in drinking water pose an unreasonable risk to public health. The precise magnitude of the risks cannot be quantified since there are many unmeasured and untested chemicals in drinking water and because the extrapolation models are imprecise and require more comprehensive national occurrence data than are currently available. However, for one group of chemicals, the THMs, a statistical extrapolation of the data indicates that a life-long exposure to these contaminants in drinking water may account for 200 excess fatalities per year nationwide. This projection assumes that the effects of chloroform are representative of THMs and that our limited occurrence data is representative of its presence generally in drinking water. Other studies would indicate even higher risks. Moreover, that computation probably underestimates the total risk since it relates only to chloroform for which occurrence and dose/response data exist. It does not include risks from any of the other trihalomethanes or other products of chlorination, or the risk from any of the myriad other synthetic organic chemicals which have been detected in drinking water.

Based on this information, EPA has concluded that synthetic organic contaminants in drinking water constitute a public health concern and that the use of granular activated carbon (GAC) in the treatment process to reduce human exposure to these chemicals where they occur is a reasonable preventive health measure. We believe that the mainstream of thinking within the scientific community will support EPA's conclusions. Since it is unlikely that the uncertainties in interpreting the toxicological data will be resolved in the near future, regulatory action to reduce these apparent risks using the best technology presently available, GAC, is deemed warranted at the present time.

REGULATORY APPROACH

In developing National Interim Primary Drinking Water Regulations for the control of synthetic organic chemicals, EPA considered the two regulatory approaches available under Section 1401 of the Safe Drinking Water Act. These two regulatory options consist of establishing a maximum contaminant level for the contaminant and/or prescribing a treatment technique for the control of such contaminant.

For synthetic organic chemicals in drinking water, the Administrator has concluded that a treatment technique should be prescribed based upon his judgment that it would not be techno-

logically or economically feasible to monitor for the presence of all the synthetic organic chemicals in drinking water which may have an adverse effect on human health. As previously noted in the introduction to this two-part amendment to the regulations, there are thousands of organic compounds potentially present in drinking water in small quantities. Only with the application of sophisticated analytical techniques such as gas chromatography/mass spectrometry in the early 1970's have researchers been able to begin to identify and quantify many of the trace synthetic organic contaminants in drinking water. However, based upon what we presently know about these chemicals that have been identified and for which toxicological data are available, there is sufficient reason to believe that the presence of synthetic organic chemicals in drinking water, both those we can currently measure and those which may be identified in the future, pose a risk to human health. Moreover, it is likely that this health risk may be heightened by the potential for synergistic effects among the many chemicals known to be, and which may be, present in drinking water.

Monitoring feasibility is the critical determinant as to whether a contaminant or group of contaminants should be controlled by means of an MCL or a treatment technique under Section 1401 of the Act. If an MCL(s) is specified, a public water system is required to conduct periodic monitoring to insure that the level of such contaminant in the drinking water does not exceed that established by the MCL.

The infeasibility of monitoring on a routine basis for all the synthetic organic chemicals about which there is cause for concern was a key determining factor in the Administrator's decision to prescribe a treatment technique. For the purposes of this treatment technique, approximately 60 individual compounds have been listed in Table I, representing key indicators of synthetic organic chemical contamination and each of them can be and has been detected in drinking water by available methods. However, there are presently no surrogates or group analytical schemes which would permit economical routine sampling and analyses to be performed to determine whether specific maximum contaminant levels have been exceeded. Research is continuing on identifying and demonstrating methods for detecting groups of compounds. Total organic halogen (TOH) or total organic chlorine (TOCl) is one method being developed which shows promise. TOCl could have application in assessing raw water quality as an indicator of synthetic chemical contamination, or as a measure of the performance of GAC over time in reducing those con-

taminants, thus indicating the need for reactivation. TOCl and other such group parameters are being actively considered for possible future use in applications related to this regulation.

Monitoring for the list of chemical indicators is feasible for the limited purpose of determining whether a public water system's raw water supply is subject to significant contamination by synthetic organic chemicals and thereby eligible for a variance from the treatment technique requirement. However, the combined costs of monitoring for even all known synthetic organic chemicals to determine specific levels of such contaminants as would be required for judging compliance with a lesser number of MCL's would be clearly excessive and thereby unreasonable.

Based upon these considerations, the establishment of an MCL(s) for synthetic organic chemicals was not deemed to be a feasible regulatory approach at this time. As additional knowledge is gained with respect to the use of surrogate parameters as a means for monitoring for synthetic organic chemicals, and as analytical capabilities are improved and methods and technologies further developed, MCL's for synthetic organics or their surrogates will be included in EPA's Revised Primary Drinking Water Regulations.

A treatment technique is also preferable to MCL requirements for the control of synthetic organic chemicals because of the flexibility which it affords as a regulatory tool. Whereas an MCL requires a public water system to provide treatment to reduce the concentration below the acceptable level however much that MCL has been exceeded, the treatment technique requires the system to operate a treatment process using GAC which has been designed to achieve a specified set of conditions. Once the system has been so designed and is operational, it must thereafter be operated in such a manner so as to reduce the level of synthetic organic chemicals to the maximum extent feasible, using the appropriate type of carbon, contact time and regeneration frequency. Because States with primary enforcement responsibility would have the ability to take into account diverse factors such as the nature of the raw water source, and other local conditions in issuing variances from a treatment technique, they would have the lead role in controlling synthetic organic contamination. These factors are not easily incorporated into an inflexible national standard such as an MCL.

Finally, variances may be granted from an MCL requirement only if the MCL cannot be achieved despite the application of best available technology, and such variances must be conditioned upon a compliance schedule

which requires compliance as expeditiously as practicable. Variances from a treatment technique are issued under entirely different conditions in that they may be granted upon a showing that the system's raw water is of such quality that the application of a treatment technique is not necessary for the protection of the health of persons.

The treatment technique requirement proposed herein is intended to limit the public's exposure to all of the synthetic organic chemicals present in drinking water which are believed to pose a risk to human health, and not just those chemicals for which MCLs could conceivably be established. This approach is clearly consistent with the preventive philosophy of the Safe Drinking Water Act and its legislative history. There is no doubt that by requiring systems to install and properly operate a granular activated carbon system as part of their treatment process, the public will be the beneficiaries of cleaner, more healthful drinking water.

SELECTION AND APPLICABILITY OF THE TREATMENT TECHNIQUE REQUIREMENT

Under Section 1401 of the Safe Drinking Water Act, the Administrator is directed to specify each treatment technique known to him which would lead to a reduction in the level of the contaminant sufficient to protect public health to the extent feasible. As discussed in the Statement of Basis and Purpose, and Treatment Guide, several available treatment technologies for organic chemical reduction have been examined by the Administrator. These included carbon adsorption, resin adsorption and aeration. The use of GAC has been found to be the best broad spectrum treatment technology currently available for controlling these contaminants and therefore is the only technology being specified at this time. However, although GAC is required in the proposed treatment regulation, a system which can demonstrate that an alternative treatment technique is at least as efficient as GAC in reducing the levels of a broad spectrum of synthetic organic chemicals may be granted a variance conditioned on the use of that alternative treatment technique.

In accordance with the Agency's phased regulatory approach to the control of organic chemicals in drinking water, the proposed treatment technique requirement is initially made applicable to community water systems serving a population of more than 75,000 individuals. As noted in the discussion of the MCL for total trihalomethanes, this requirement will affect 52 percent of the total population served by community water systems.

As with the MCL for TTHMs, a considerable level of protection is pro-

vided by this regulation since it applies to those locations most likely to be subject to contamination from synthetic organic chemicals. Synthetic organic chemical contamination is mainly found in surface water sources of drinking water which receive upstream chemical discharges from industrial facilities and urban and agricultural runoff. Surface waters are the predominant source of drinking water for most large community water systems covered by this regulation, whereas most smaller systems receive their drinking water from groundwater sources, less likely to be subject to synthetic organic contamination.

Furthermore, the use of granular activated carbon in the treatment of drinking water is a relatively new and sophisticated technology. It is not now standard practice in the United States, although about 40 cities now use GAC filtration to improve the taste and odor of their drinking water. Careful supervision is essential for the proper design and operation of GAC system to efficiently and consistently reduce the levels of synthetic organic chemicals in drinking water.

The larger systems generally have access to the requisite engineering experience and trained personnel to implement the GAC treatment technique. Moreover, due to the limited amount of technical assistance available from EPA and the States, it was deemed necessary to limit the initial number of systems that would be required to make treatment modifications.

Finally, because GAC is a costly technology, it was not deemed economically feasible for the smaller systems to incur the relatively higher per capita costs of GAC treatment technology at the present time. Larger systems will be better able to keep the added cost burden on the individual consumer to a reasonable level.

As additional operating and technical experience is gained with respect to the use of GAC for the treatment of drinking water, the scope of this treatment technique requirement will be expanded to include smaller community water systems. Based upon further knowledge to be gained through experience within the next two years, it is also possible that the design criteria for GAC treatment may be modified to reflect such additional experience gained. Smaller systems will thus benefit from the experience gained in the initial application in large systems.

In the meantime, all water systems should strive to minimize synthetic organic chemical concentrations to the extent technologically and economically feasible. To this end, the smaller public water systems are strongly urged to seek technical assistance from the States and EPA to reduce these undesirable contaminants from

their drinking water supplies. A few smaller systems with sufficient resources are already using granular activated carbon in their treatment processes and are encouraged to continue doing so. EPA will be actively expanding its data base with respect to the application to GAC technology to small systems.

THE TREATMENT TECHNIQUE REQUIREMENT

The proposed technique requirement ultimately requires each community water system which serves a population of greater than 75,000 individuals (and which is not granted a variance from the regulation) to operate a treatment system using granular activated carbon (GAC) no later than 3½ years after the effective date of this regulation. Since the effective date will be 18 months after promulgation of this regulation, a system would actually have 5 years to comply with this ultimate treatment technique requirement. The treatment system using GAC would have to be designed to meet designated criteria to ensure maximized reduction of synthetic organic chemicals in drinking water.

This lengthy timeframe was deemed necessary in order to provide systems a reasonable amount of time to gather the information prerequisite to the granting of a variance where appropriate, to conduct pilot studies to determine the specific optimal design parameters of each GAC treatment system and to construct the system. The Agency is fully aware that this treatment technique requirement involves a significant departure from existing water treatment practice. It is therefore desirable to accord systems subject to the regulation sufficient time to proceed with care in designing a treatment process which will provide the most effective reduction in the level of synthetic organic chemicals in drinking water for maximizing public health protection. On the other hand, it was also deemed necessary to prescribe a timeframe which would require action with all deliberate speed. Exemptions may be granted from this timeframe according to Section 1416 of the Safe Drinking Water Act.

Important consideration was also given to the necessity of providing States with primary enforcement responsibility adequate time to incorporate these new regulations into their State enforcement programs. In order for a State to maintain primacy, its statutory and regulatory authority must satisfy the requirements of Section 1413 of the Safe Drinking Water Act which requires that State regulations be no less stringent than those federal regulations which are in effect. Eighteen months was deemed to be a reasonable amount of time to allow States to amend their regulations

and/or enabling legislation in conformance with this requirement. Once the new regulations have been incorporated, States with primary enforcement responsibility will have the authority to grant or deny variances from the treatment technique and to ensure that systems ultimately subject to the treatment technique requirements comply with the regulations, including the intermediate milestones contained herein.

The treatment technique requirement as set forth in Subpart F of 40 CFR Part 141 requires that the treatment system using GAC be designed to meet three specific criteria to insure that the system has been designed to optimize the reduction of synthetic organic chemicals in drinking water. These three criteria are related to the breakthrough of "volatile" halogenated organic compounds and total organic carbon (TOC) and have been determined to be the current best surrogate indicators for determining whether a GAC system is providing maximum effective removal of a broad spectrum of synthetic organic chemicals generally. The Agency's selection of these design criteria is more fully discussed below.

Due to the extended timeframe (3½ years after the effective date) provided for the ultimate construction and operation of the GAC treatment system, and the unavailability of exemptions conditioned upon compliance schedules that extend beyond January 1, 1981 (or of a case of a system which enters into an enforceable agreement to become part of a regional water supply system, January 1, 1983), it was deemed necessary to establish intermediate compliance milestones. This enables the enforcement authority to ensure that satisfactory progress is being made and due diligence is being exercised towards meeting the final goal. These increments of progress will not only serve as an enforcement mechanism for the State and/or EPA, but will provide each affected system with assurance that it is proceeding in conformance with the requirements in the regulations.

Thus, a community water system which serves a population of greater than 75,000 persons will initially have to determine whether it will request a variance from the treatment technique requirement based upon an assessment as to whether its drinking water source is subject to significant contamination by synthetic organic chemicals. During the 18 month period between the promulgation of these regulations and their effective date, a system which decides to request a variance should be conducting such monitoring and gathering such other information which would be necessary to demonstrate to the State, or EPA where the State does not have

primary enforcement responsibility, that it satisfies the variance conditions. By not later than the effective date of the regulation, those systems desiring variances are required to have submitted a variance request to the appropriate enforcement authority.

Pilot studies should be begun as soon as possible so that by not later than six months after the effective date of the regulations, the system will be prepared to submit to the State for approval the design specifications of its GAC treatment system which will satisfy the three criteria set forth in the regulation. Such pilot studies may be conducted using as influent either the system's actual raw water supply or such other water of comparable quality which can serve as a reasonable surrogate for the presence (in comparable quantity and types) of synthetic organic chemicals in the actual water to be treated. Thus, data from pilot studies conducted on the raw water supply of a system whose intake point is upstream from a second system's intake point, and where there are no significant sources of synthetic contamination between the two points might be used by the second system as the basis for the establishment of its design criteria.

In some cases, a system may be delayed in conducting its pilot studies, and thereby be unable to submit its design specifications by the sixth month after the effective date of the regulations, due to an unforeseen delay in the processing of its variance request. Such systems may request an exemption from that particular requirement which may extend the compliance date until not later than January 1, 1981, or January 1, 1983 for those systems which have entered into an enforceable agreement to become part of a regional public water system.

Due to the statutory limitations of such time extensions, however, systems are encouraged to submit their variance requests as early as possible prior to the effective date.

At that point, the system should have determined the scope of the changes which will have to be made to its existing treatment process in order to comply with the treatment technique requirement. In some cases, this may involve merely replacing the system's existing filter media with GAC. In most cases, however, it will be necessary for a system to install GAC post-contactors which will involve significant new construction. Which of these options will be chosen to comply with the treatment technique requirement in any given situation will be dependent upon water quality and the configuration of the existing facility, as well as optimization of technological and economic considerations. Each specific system's design will be determined on a case-by-case basis upon ap-

propriate pilot studies and consultation with the State and EPA who will be equipped to provide the technical assistance in implementing this treatment technique requirement.

In light of the need to reduce public exposure to synthetic organic chemicals in drinking water by the best available means as soon as possible, it was deemed necessary to require the use of an interim control measure in those cases where treatment systems using GAC would not be operational until from 2 to 3½ years after the effective date. Contamination of some public water supplies by synthetic organic chemicals is sufficiently significant to warrant short-term improvement of water quality while further work is underway. It was therefore not believed to be prudent to wait as long as 5 years after the promulgation for optimal systems to be installed and operative for accomplishing any reduction in the level of synthetic organic chemicals in drinking water.

Thus, any community water system subject to the treatment technique requirement is also required to replace its existing filter media with GAC as an interim control measure not later than one year after the effective date of the regulations, unless it demonstrates to the satisfaction of the State that the failure to implement such a control measure will not result in an unreasonable risk to health, and that either of two conditions are satisfied. First, the interim control measure may be waived by the State if the system shows that its GAC treatment system will in fact be operational in compliance with the treatment technique requirement not later than 2 years after the effective date. The interim control measure may also be waived by the State if the System demonstrates that due to compelling physical circumstances, the cost of replacing its existing filter media with GAC would be unreasonably high when considered in light of the accompanying reduction in the level of synthetic organic chemicals that would be achieved using such an interim remedial measure. For example, a vulnerable water system subject to the treatment technique requirement may be excused from the interim control measure if it shows that the depth of its filter beds is so small that the removal capacity of that small an amount of carbon would be inconsequential and the cost unreasonably high. The case might arise that in order to achieve a reasonable removal efficiency with GAC, it would be necessary to increase the size of the existing filter beds at a cost which would be unreasonable or which would be physically impossible due to structural constraints at the treatment facility. The decision as to whether this interim control is waived for any particular system would be

made on a case-by-case basis by the State, or EPA where the State did not have the primary enforcement responsibility.

Once the existing filter media have been replaced with GAC by those systems required to implement the interim control measure, the carbon is required to be replaced or regenerated not less frequently than once every 6 months. This was deemed a reasonable time based upon a consideration of the removal efficiency of GAC being replaced in an average filter bed and cost of replacement of such a frequency. Under these operating conditions, although weakly adsorbed compounds like dichloroethane would break through the GAC, many strongly adsorbed chemicals such as polynuclear aromatic hydrocarbons would still be removed efficiently. Also the GAC would constitute a protective barrier from unusual events such as chemical spills into the raw water sources. Comment is solicited from the public as to whether this is a reasonable requirement.

In some cases, a system might demonstrate through monitoring data that even after six months, the use of GAC in its existing filter beds is allowing its treatment system to meet the three design criteria specified for the treatment technique requirement. In those cases, such a system may regenerate the carbon less frequently. Regeneration must then occur at a frequency which will not allow the criteria to be consistently exceeded.

Approximately 40 public water systems in the United States currently use GAC in their filter beds, principally for taste and odor control. The required interim control measure is therefore feasible and can be installed with minimum delay in other systems to provide some degree of interim public health protection.

Whether or not a system replaces its existing filter media with GAC as an interim control measure, by not later than 18 months after the effective date, the system must submit to the State for approval its final design plans and specifications and a construction schedule for the GAC treatment systems. Finally, by not later than 3½ years after the effective date, each system subject to the treatment technique requirement must notify the State that construction of the GAC treatment system has been completed and that it is being operated to maximize the removal of synthetic organic chemicals in drinking water.

DESIGN CRITERIA FOR THE REQUIRED TREATMENT TECHNIQUE

The performance of a granular activated carbon (GAC) treatment system has been shown to vary considerably with the design of the system and the characteristics of the raw water. For a

discussion of the scientific data on which these and the following judgments are based, see the "Interim Treatment Guide for Controlling Organic Contaminants in Drinking Water Using Granular Activated Carbon," incorporated by reference herein. If inadequate contact time is provided in the system, then removal of organic contaminants will be less than ideal with fresh carbon. Further, as the GAC remains in the treatment system, in time its adsorptive capacity will gradually be used up, resulting in the breakthrough of some organic chemicals. Finally, different types of carbon vary in their adsorptive capacity (for which no generally accepted measurement technique exists). Thus, the design of the system must specify at least three factors: contact time, regeneration frequency, and type of carbon.

In the absence of pilot study data on the specific water to be treated, the performance of the GAC system will not in general be predictable since it can and does vary widely with the characteristics of the raw water, particularly the types and amounts of organic chemicals present. Because of this, it is not possible to specify maximum or minimum values for these parameters applicable to all systems in the proposed regulations. On the other hand, some criteria must be provided so that the requirements imposed on public water systems can be adequately specified.

To deal with this problem, the regulations specify three criteria which the GAC system should be designed to achieve. The design of each system should be based in part on pilot studies using the system's raw water to determine the configuration which would best satisfy the criteria in a particular situation. These criteria are:

1. The concentration in the effluent of any of the volatile halogenated organic compounds (except for trihalomethanes) determinable by the purge-and-trap/gas chromatography method shall not exceed 0.5 µg/l;
2. The removal of influent total organic carbon with fresh activated carbon shall be at least 50 percent; and
3. The effluent total organic carbon may not exceed the value with fresh activated carbon by more than 0.5 mg/l. Of course, the design must also assure that the requirements specified in the interim primary regulations are also met, including THM concentrations, disinfectant demand and concentrations of other regulated chemicals.

The first criterion has been chosen because the volatile halogenated organic compounds measurable by the purge and trap technique tend to break through GAC earlier than other, heavier compounds. The vola-

tile halogenated organics are common industrial chemicals found as contaminants in drinking water. The presence of these chemicals should also be indicative of the presence of other potentially hazardous substances which would be more difficult to detect. In addition, some of them, such as carbon tetrachloride and trichloroethylene, have been identified as carcinogens by the National Academy of Sciences. Thus, using these compounds as the basis for one of the design criteria provides a margin of safety, in that it is unlikely that other, possibly carcinogenic, compounds will break through the carbon before these do. The value of 0.5 µg/l has been chosen as an operational value, which is above that achievable by a system using fresh GAC with reasonable contact times and one which is really measured by the stated analytical method without excessive analytical error, thus making the breakthrough relatively unambiguous. The system should be designed so that GAC which has been used long enough to allow these compounds to break through consistently (3 week running average) should be regenerated. In most cases this is expected to permit at least several months of operation between regenerations.

The second and third criteria are designed to deal with the situation in which a system's raw water source may not contain significant amounts of the volatile compounds measurable by the first criterion. Total organic carbon (TOC) is a measurement of all of the organic compounds present in the water. Because it tends to give excessive weight to naturally occurring high molecular weight compounds which are not believed to be hazardous, it is not suitable as the sole criterion for the design of a GAC system. However, when a consistent significant breakthrough of TOC is observed, it could indicate that the GAC is becoming saturated in its ability to remove some of the potentially harmful synthetic organic compounds and is therefore ready to be regenerated. The target value of 0.5 mg/l allowable increase in TOC is unambiguous analytically. The second criterion of at least 50 percent initial removal of TOC should be easily achievable with GAC but is necessary to make the third criterion meaningful and to assure sufficient adsorptive activity of the carbon.

It should be emphasized that these criteria should not be construed as maximum contaminant levels in disguise. Rather, they are intended to be the objectives which the GAC treatment system should be designed to achieve in those public water systems subject to the treatment technique requirement. Thus, for example, a system whose raw water does not satisfy the first criterion would not automatically be denied a variance. More-

over, the second and third criteria cannot by their nature be interpreted as MCL's. The Agency solicits comments on the appropriateness of its approach to satisfying the required treatment technique and on the particular criteria proposed. MCL's will ultimately be established in Revised Drinking Water Regulations in accordance with the SDWA for compounds for which monitoring is technological and economically feasible.

VARIANCES FROM THE REQUIRED TREATMENT TECHNIQUE

Although the GAC treatment technique is initially applicable to all community water systems serving a population of greater than 75,000 people, a system may request a variance from its requirements. The system should follow the procedures established for requesting a variance provided in Section 142.20 for State-issued variances or Subpart E of Part 142 of the implementation regulations for EPA-issued variances.

In accordance with Section 1415(a)(3) of the Safe Drinking Water Act (SDWA), to receive a variance, a system must demonstrate that the prescribed treatment technique is not necessary to protect the health of persons because its raw water source is not subject to, nor likely to be subject to, significant synthetic organic chemical contamination. These proposed regulations prescribe the demonstration which a system must make in order to satisfy the statutory requirement. By the use of the variance procedure, only those systems whose raw water sources warrant treatment for synthetic organics will be required to install granular activated carbon. Nevertheless, each affected system has the burden of proof in demonstrating that its particular circumstance warrants the granting of a variance from the treatment technique requirement designed to protect the public health.

In order to be considered for a variance, a system must submit information of two basic types to the appropriate authority. First, the system must provide information with respect to those point and non-point sources of pollution that would likely be potential sources of synthetic organic chemical contamination for the system's drinking water supply. This requirement was included because upstream polluters are considered to be one of the most important contributors to chemical contamination of drinking water. The identification of these pollution sources will serve as a significant link between drinking water programs and programs under the Federal Water Pollution Control Act. Systems are thereby encouraged as a preventive measure to look for the sources of contamination problems and to the extent possible to improve

the quality of their raw water supplies. To the extent feasible, systems must provide information with respect to the location of the particular dischargers and the characteristics of their discharges, such as types and concentrations of chemicals in the normal discharges as well as the potential for accidental spills. This information is needed to give the variance-issuing authority the ability to assess the likelihood that a system's raw water supply may be contaminated by synthetic organic chemicals on a case-by-case basis based upon local conditions.

The second type of information which a system requesting a variance is required to provide is analytical data on the quality of the system's raw water. As previously discussed, although it is not feasible to require systems to monitor for the presence of all the specific synthetic organics which may pose a potential public health risk to drinking water consumers, the presence of particular compounds which have been identified and which are known to present significant health problems is deemed to be a reasonable surrogate indicator of the presence of other potentially harmful contaminants. Variance-issuing authorities are therefore required to utilize the data provided by the variance-seeker on the presence of chemical indicators in Table I as well as any other available information in making the determination of the appropriateness of issuing a variance in a given situation.

As a guide to the variance-issuing authorities, the following list of chemical indicators (Table I) of industrial contamination has been prepared. This list includes compounds which have been found in drinking water supplies and for which there is suspicion or confirmation of adverse health effects. This list is derived from the report of the National Academy of Sciences, "Drinking Water and Health" and from EPA's list of 129 priority pollutants in effluent discharges. For convenience it is divided into general classes of organic compounds as these are easier to discuss because of their chemical similarities. This list is intended to serve as a guide for the purpose of aiding in the determination for the granting variances. Testing for these compounds is feasible and their presence would be indicative of chemical pollution and therefore of the fact that the particular water source is vulnerable to synthetic chemical contamination. Obviously many other chemicals besides those listed could be present. Therefore, the list does not comprise all possible pollutant chemicals but is intended as a surrogate for the possible presence of many other chemicals for which analysis would be technically as well as economically in-

feasible. This list may be modified as additional information is gathered.

TABLE I.—Chemical indicators of industrial contamination

- I. *Aliphatic halogenated hydrocarbons:*
 - Methane derivatives:* Dichloromethane, trichlorofluoromethane, dichlorodifluoromethane, and carbon tetrachloride
 - Ethane derivatives:* 1,1-dichloroethane; 1,2-dichloroethane; hexachloroethane; 1,1,1-trichloroethane; 1,1,2-trichloroethane; 1,1,2,2-tetrachloroethane
 - Unsaturated hydrocarbons:* Trichloroethylene, tetrachloroethylene, vinyl chloride, 1,1-dichloroethene; 1,2-dichloroethene; 1,3-dichloropropene; hexachlorobutadiene; 2-chlorovinyl ether
 - Other halogenated compounds:* 1,2-dichloropropane, bis (2-chloroethyl) ether, bis (2-chloroisopropyl) ether
- II. *Cyclic aliphatic compounds:*
 - Chlorinated hydrocarbons:* Lindane and BHC, Kepone, toxaphene
 - Cyclodienes:* Hexachlorocyclopentadiene, aldrin, dieldrin, chlordane, heptachlor, heptachlor epoxide, endrin
- III. *Aromatic hydrocarbons:* 3,4-benzofluoranthene; benzo (k) fluoranthene; 1,12-benzoperylene; fluoranthene, indeno (1,2,3-cd) pyrene and benzo(a)pyrene
- Benzenes:* Benzene, toluene, xylenes, ethylbenzene, propylbenzene, styrene
- Halogenated aromatics:* Chlorinated naphthalenes, chlorobenzene, dichlorobenzenes, trichlorobenzenes, polychlorinated biphenyls, bromobenzene, DDT, DDE, DDD, chlorophenols, pentachlorophenol, 4-bromophenylphenyl ether; 4-chlorophenylphenyl ether, hexachlorobenzene
- Other aromatic hydrocarbons:* Nitrobenzene, dinitrotoluene, phthalate esters, atrazine

The proposed regulations further provide the variance-issuing authority with the flexibility to require submission of such other information as it may deem necessary in determining whether a variance is warranted. All information available to the variance-issuer should be taken into consideration, including such information which it may have in its possession with respect to other regulatory programs, under the FWCPA, such as through the NPDES permit program, and the Section 208 plan program. Comments are solicited from the public as to the reasonableness of requiring the submission of these types of information as the basis for granting or denying variances from the treatment technique requirement.

The Agency expects that particular sources of drinking water are less likely to be subject to contamination by synthetic organic chemicals. These include systems whose raw water sources consist exclusively of water from deep ground aquifers, protected watersheds such as upland reservoirs, the Great Lakes where substantial dilution is known to take place, or water purchased from a supplier of water which is treating its water using granular activated carbon, because the

likelihood of potential synthetic organic chemical contamination of these sources is smaller. These systems are expected to receive variances relatively easily. Nevertheless, variance-issuing authorities are precluded from granting a variance if based on other information, it finds that significant contamination exists which requires the system to comply with the treatment technique to protect the public health from the adverse effects of synthetic organic chemicals. Comments are solicited as to the Agency's assumption that these raw water sources of drinking water are not likely to be subject to contamination and whether they may warrant the imposition of less stringent requirements for being granted a variance.

In addition to a variance based on water quality considerations and the need for the designated treatment to be installed, Section 1415(a)(3) of the SDWA also allows variances to be granted by EPA upon a showing that an alternative treatment not included in the treatment requirement is at least as efficient in lowering the level of contaminants being controlled. Comment is also requested on other treatments which would be equivalent to GAC for organics control.

ECONOMIC IMPACT

The proposed regulation for the control of synthetic organics in drinking water is a treatment technique requirement. It specifies the use of granular activated carbon for community water supplies which are susceptible to contamination by synthetic organic compounds. In its proposed form it will initially apply only to systems serving resident populations over 75,000.

It is expected that most community water systems affected by this regulation will incorporate granular activated carbon into their treatment trains by construction of post-filtration contractors for the carbon. A typical plant serving 280,000 persons in 1981 (producing 50 MGD) would have 10 to 20 contactors depending on the required empty bed contact time (expected to range from nine to eighteen minutes), to achieve the specified operating criteria.

On-site regeneration of the spent carbon is anticipated through the use of furnaces constructed especially for this purpose. Regeneration frequencies will vary from site to site depending upon raw water quality and other factors, but should generally be between two and six months.

These variations in the use of GAC—contact time and regeneration frequency—result in large ranges in the possible costs. Contact time affects almost all in the capital expenditures

almost linearly—a doubling requires twice as many contactors, twice the initial carbon fill, and twice the furnace capacity for regeneration. Different frequencies of regeneration, on the other hand, affect only the furnace capacity and operating costs, not the other capital improvements.

In addition to the treatment costs for the individual water systems, the other major factor determining the national cost totals is the estimated number of systems likely to be required by the regulation to aid treatment. EPA has reviewed monitoring data and the inventory of community water systems and has estimated that approximately 50 systems would be impacted by the proposed regulation on synthetic organics. These systems constitute about one-eighth of all water systems serving over 75,000 persons and one-fourth of systems in this size capacity with surface water sources.

The national costs of applying granular activated carbon to these 50 systems are shown in Table II below. These costs do not include systems affected by only the THM regulation.

TABLE II.—Annual national costs of GAC treatment requirement
(In millions of 1976 dollars)

	Regeneration frequency			
	6 mo		2 mo	
Contact time.....	9 min	18 min	9 min	18 min
CAPITAL EXPENDITURES				
Population served				
75,000 to 100,000.....	31	54	44	76
100,000 to 1 million....	157	288	197	360
Over 1 million.....	37	68	45	83
Total.....	225	410	286	519
ANNUAL O&M EXPENSES				
Population served				
75,000 to 100,000.....	3	5	5	9
100,000 to 1 million....	12	23	24	43
Over 1 million.....	5	9	9	17
Total.....	20	37	38	69
ANNUAL REVENUE REQUIREMENTS				
Population served				
75,000 to 100,000.....	5	9	9	15
100,000 to 1 million....	26	47	40	74
Over 1 million.....	8	15	13	24
Total.....	39	71	62	113

The aggregate national costs for the proposed treatment requirement range as follows:

Capital expenditures will be in the range of \$225 to \$286 million if an average nine

minute contact time will be adequate to achieve the desired organics removal levels. If contact times have to increase to the point where they average 18 minutes nationally, then the capital expenditures would be \$410 to \$519 million.

Operation and maintenance expenses are more dependent upon regeneration frequency than contact time. The national range of O&M expenses will be \$20 to \$37 million if an average regeneration frequency of six months will be adequate to achieve the desired performance. However, if the average has to be as low as two months then the O&M expenses would be \$38 to \$69 million per year.

Annual revenue requirements reflect both sets of uncertainties and fall in three general positions under the range of assumptions shown. Under the best conditions they could total \$39 million per year for the 50 systems. Under the least favorable assumptions they could be as high as \$113 million. However, if either one of the key operating characteristics, contact time or regeneration frequency, turned out favorably and the other did not, then revenues would total \$63 to \$71 million per year.

These costs would ultimately be borne by the utilities' customers and reflected in their water bills.

The cost per capita shown in Table III is simply the total annual revenue requirement divided by the population served by the water system. It provides a measure of the cost of this form of health protection and is an upper bound on the possible cost to individual consumers if no cost were allocated to non-resident customers. By this measure, the utilization of GAC treatment will result in cost of approximately \$2 to \$4 per capita under the most favorable conditions and \$7 to \$11 per capita under the least favorable conditions.

TABLE III.—Annual per capita and customer costs of GAC, 1981 individual water systems
(In 1976 dollars)

	Regeneration frequency			
	6 mo		2 mo	
Contact time.....	9 min	18 min	9 min	18 min
ANNUAL COSTS PER CAPITA				
Population served				
75,000 to 100,000.....	3.80	6.70	6.30	11.00
100,000 to 1 million....	3.10	5.60	4.80	8.70
Over 1 million.....	2.20	4.00	3.60	6.50
ANNUAL RESIDENTIAL CUSTOMER BILL IMPACT*				
Population served				
75,000 to 100,000.....	5.70	10.00	9.50	16.50
100,000 to 1 million....	4.70	8.40	7.20	13.10
Over 1 million.....	2.90	5.30	4.80	8.60

* For a family of 3.

Actually, the increase in water rates will usually be less than this per capita cost because some of the costs will be borne by non-residential cus-

tomers of the water system. The other set of figures in the table is an estimate of the likely increase in annual water rates for an average family of three, assuming that non-residential customers pick up the same proportion of GAC costs that they do of other system costs. On this basis, the GAC treatments will result in annual increased water bills of approximately \$3 to \$6 per family under the best conditions shown and \$9 to \$17 per family under the worst conditions shown. Those figures would be equivalent to increased residential water charges of 3¢ to 7¢ and 10¢-19¢ per thousand gallons consumed, respectively.

The interim control measure requires systems which are susceptible to synthetic organic chemical contamination to replace the sand or other media in the existing filter bed with GAC, while the comprehensive treatment system is being designed and constructed.

The incremental per capita costs of an interim requirement to use GAC in existing filters are dependent upon the regeneration frequency and the use of on-site regeneration facilities. The annual per capita costs for an average system serving 280,000 people (50 MGD) are \$1.70 for 12-month regeneration and \$3.30 for 6-month regeneration where on-site regeneration is not available. With on-site regeneration the costs are \$1.10 and \$1.50 per capita.

COMBINED COSTS OF TRIHALOMETHANE AND SYNTHETIC ORGANICS REGULATIONS

The two proposed regulations have each been evaluated separately in terms of economic impacts on the country, individual systems, and customers. The impact of the proposed trihalomethane regulation was assessed in the August 1977 report referred to earlier and discussed earlier in this preamble. The impact of the proposed treatment requirement was described briefly in the preceding section, and in detail in the report entitled: "Economic Analysis of Proposed Regulations on Organic Contaminants in Drinking Water," by Temple, Barker and Sloan, Inc., December 13, 1977.

The majority of the systems impacted by these regulations are expected to be affected by only one of them.

For those systems and their customers, the costs of compliance will simply be the costs which are described in the appropriate individual analysis.

A small number of systems, approximately 15, are expected to be both of the regulations as shown in Table IV. Since the costs for these systems have been included in both of the separate cost analyses, the combined costs of the two regulations are less than the sum of the individual costs.

For those systems affected by both

regulations, the choice of compliance method will be constrained to the use of granular activated carbon, and the operating parameters of contact time and regeneration frequency will have to be designed to achieve both sets of requirements. Accordingly, some individual systems may be forced to operate with longer contact times or more frequent regeneration than would be possible if affected by only one regulation, though all are expected to fall within ranges described in the previous chapter.

TABLE IV.—Estimated number of systems affected by both proposed regulations

	Regulation			Total systems affected
	THM only	Treatment requirement only	Both	
Total number of systems affected	71	35	15	121
Number of systems using GAC	11-23	35	15	61-78

In combination, the two regulations are expected to require between 61 and 78 large water systems to utilize granular activated carbon or an equivalent treatment. Of that number 11 to 28 systems will install carbon treatment solely to comply with the triha-

lometane regulation, 35 will install it solely to meet the treatment requirement, and 15, as noted above will use it to meet both requirements.¹

The national costs of the combined regulations are shown in Table V below.

TABLE V.—National combined costs THM and treatment requirement regulations
(Millions of 1976 dollars)

	Regulation			Total costs
	THM only	Treatment requirement only	Both	
Low cost assumptions*				
Capital expenditures	\$68	\$155	\$70	\$291
O/M Expenses	14	14	6	34
Annual revenues	18	27	12	57
Mid-cost assumptions*				
Capital expenditures	68-168	198	88	352-45
O/M expenses	14-23	28	12	52-61
Annual revenues	18-32	43	19	80-94
High-cost assumptions*				
Capital expenditures	168	359	160	685
O/M expenses	23	48	21	92
Annual revenues	32	78	35	145

* See text for explanation of assumptions.

The national costs may vary significantly depending upon the local conditions which prevail at the systems affected by the regulations. The table presents costs for three different sets of assumption:

¹The range associated with the trihalomethane regulation shown in this and later tables reflects uncertainty on the proportion of affected systems which will utilize carbon, ranging from a low of 30 percent to a high of 50 percent.

Low cost assumptions, which project that only 11 systems would add GAC treatment under the trihalomethane regulation alone and that the treatment requirement could be satisfied with 9 minute contact time and 6 month carbon regeneration.

Mid cost assumptions, which show a range of 11 to 28 systems which will add carbon under the trihalomethane regulation alone and which assume that the regeneration frequency would be shortened to 2 months with 9 minute contact time.

High cost assumptions, which project that 28 systems would add carbon under the trihalomethane regulation alone and that the regeneration frequency would be reduced to 2 months and the contact time would be increased to 18 minutes.

The total national capital expenditures required for these combined regulations is estimated to be \$291 million under the low-cost assumptions, \$352 to \$452 million under the mid-cost assumptions. The aggregate operations and maintenance expenses are estimated to range from \$34 million to \$92 million under these various assumptions, and \$685 million under the high-cost assumptions. The annual revenues required to cover the capital and operating expenses for those 121 affected systems are projected to be \$57 million under the low-cost assumptions, \$80 to \$94 million for the mid-cost case, and \$145 million for the high-cost case.

The per capita and per customer costs of a specific treatment at the in-

dividual systems level, of course, will be no different than the costs shown under the individual regulation analyses.

DEMAND ON SUPPLYING INDUSTRIES

The treatments required by both the THM and the synthetic organics regulations will result in large increases in the demand for GAC and for regeneration furnaces. The demand for GAC as initial fill will be determined by the number of systems adding GAC treatment and the contact time required. The annual replacement of GAC lost in the regeneration process will be set by the frequency of regeneration.

Each water system adding GAC treatment is likely to purchase a regeneration furnace, the size of which will vary according to the quantity of carbon the system plans to regenerate. For the largest systems, generally those serving more than 1 million people, the purchase of more than one furnace would be required. Systems with multiple treatment plants would also generally be expected to purchase two or more furnaces.

Table VI estimates the quantity of carbon, both as initial fill and annual replacement, which will likely result from the combined THM and treatment regulations. The three rows of this table represent the low-cost and high-cost assumptions discussed in the previous chapter.

TABLE VI.—Demand on supplying industries of the combined regulations

	Number of systems selecting GAC ^a	Demand for GAC (millions of pounds)		Expected demand for furnaces
		Initial fill ^b	Annual replacement ^b	
Low-cost assumptions	61	112	26	64-80
Mid-cost assumptions	61-78	112-134	47-56	64-97
High-cost assumptions	78	211	89	81-100

^a Assumes 22,600 lbs. of GAC per MGD for 9-minute contact time and 45,200 lbs. of GAC for 18-minute contact time.

^b Based on 7 pct. losses per regeneration cycle.

The demand for both GAC and regeneration furnaces generated by the proposed regulations is within the capacity of the respective industries. The activated carbon industry was reported to have an unutilized annual production of some 100 million pounds of GAC in mid-1976. Since that time, one firm has announced plans to add new capacity for GAC production. The industry's expanded capacity appears likely to exceed anticipated demand (excluding new uses for drinking water treatment) by the same 100 million pound level until 1980. Hence, the industry is capable of supplying the 112 to 211 million pounds of GAC needed by the affected water utilities over the next three years. It should be noted, however, that the highest estimate of

211 million pounds corresponding to the high-cost assumptions that would require full use of the industry's capacity for more than two years and could only be supplied within that time frame with advance planning and contracting and in the absence of large competing demands. In the longer perspective, beyond the initial requirement of this regulation in its first two or three years, the carbon industry has indicated an intent to expand its capacity to whatever level is required to supply the recurring annual volumes of carbon needed by the water supply industry.

The regeneration furnaces needed by the utilities adding GAC could be supplied by the furnace manufactur-

ers over a three-year time period. Multi-hearth furnace producers have estimated that their collective capacities could be increased by as many as 100 furnaces annually. Rotary kilns, infra-red electric furnaces, and fluidized bed furnaces also could be made available to water utility customers. The design and installation of reactivation furnaces, particularly multi-hearth furnaces, requires some 18 months of lead-time, though this time frame might be reduced by the availability of pre-engineered designs in the future.

Fuel use by regeneration furnaces ranges widely by furnace type, size, and rate of utilization. Using 3700 Btu per pound of GAC regenerated as an estimated midpoint of this range, annual fuel consumption under the mid-cost assumptions reviewed earlier would be from 2.5 to 3.0 trillion Btu. This converts to 426 to 510 thousand barrels of distillate fuel oil or 2.5 to 3.0 BCF (billion cubic feet) of natural gas. On a national basis, these are relatively small quantities. If fuel oil were used exclusively, demand would equal approximately 0.04 percent of 1976 domestic distillate fuel oil demand or less than 0.01 percent of domestic crude oil demand. If natural gas were used, demand would be between 0.01 and 0.02 percent of 1976 domestic production.

The furnaces used for regeneration would need to be equipped with after burner and scrubber equipment to meet air pollution standards. This equipment is available and effective in reducing emissions to required levels. Its costs have been included in the capital and operating costs for regeneration furnaces and incorporated in the above figures.

Neither an environmental impact statement (EIS) nor an inflationary impact statement (IIS) was prepared in conjunction with the proposal of these regulations. However, this proposed regulation, including the supporting documentation incorporated by reference herein, provides information fundamentally equivalent to that which would be provided through an EIS and IIS. Therefore it has not been deemed necessary to prepare the formal EIS and IIS with respect to these regulations.

Dated: January 26, 1978.

DOUGLAS COSTLE,
Administrator.

Accordingly, Part 141, Chapter 40 of the Code of Federal Regulations is hereby proposed to be amended as follows:

1. By amending § 141.2 to include the following new paragraphs (p) through (s):

§ 141.2 Definitions.

(p) "Halogen" means one of the chemical elements chlorine, bromine or iodine.

(q) "Trihalomethane" (THM) means one of the family of organic compounds, named as derivatives of methane, wherein three of the four hydrogen atoms in methane are each substituted by a halogen atom in the molecular structure.

(r) "Total trihalomethanes" (TTHM) means the sum of the concentrations in milligrams per liter of the trihalomethane compounds (trichloromethane, dibromochloromethane, bromodichloromethane and tribromomethane, rounded to two significant figures).

(s) "Disinfectant" means any substance added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms.

2. By revising § 141.6 to read as follows:

§ 141.6 Effective dates.

(a) Except as limited by paragraphs (b) and (c) the regulations set forth in this part shall take effect on June 24, 1977.

(b) The regulations for trihalomethanes set forth in § 141.12(c) and the requirements of § 141.21 (j) and (k) shall take effect 18 months after the date of promulgation of those regulations. The sampling and analytical requirements under § 141.21(i) and 141.24 (g) through (j) shall take effect 3 months after the date of promulgation. Sampling and analysis requirements under § 141.25(b) shall take effect 6 months after promulgation.

(c) The treatment technique requirements of Subpart F of this Part shall take 18 months after the date of promulgation of that subpart.

3. By revising the introductory paragraph and adding a new paragraph (c) in § 141.12 to read as follows:

§ 141.12 Maximum contaminant levels for organic chemicals.

The following are the maximum contaminant levels for organic chemicals. The maximum contaminant levels for organic chemicals apply only to community water systems.

The maximum contaminant level for total trihalomethanes applies only to community water systems which serve a population of greater than 75,000 individuals and which add a disinfectant to the water in any part of the drinking water treatment process. Compliance with maximum contaminant levels for organic chemicals is calculated pursuant to § 141.24.

(c) Total trihalomethanes [the sum of the 0.10 mg/l concentrations of bromodichloromethane, dibromochlo-

romethane, tribromomethane (bromomethane) and trichloromethane (chloromethane)]

4. By amending § 141.21 to include the following new paragraphs (i), (j) and (k).

§ 141.21 Microbiological contaminant sampling and analytical requirements.

(i) Whenever a community water system, in order to achieve compliance with § 141.12(c), makes any modification to existing disinfection practice, monitoring for the presence of general bacterial populations (in addition to the coliform analyses required by §§ 141.14 and 141.21) shall be performed on finished water at the treatment plant and in the distribution system to ensure that no degradation in bacteriological quality of the water has or is likely to occur as the result of such modification. These analyses shall be performed using the Standard Plate Count (SPC) method in conjunction with the coliform analyses. (Standard Methods, 14th Ed., pp. 908-913). An appropriate number of SPC analyses as determined by the State shall be performed at least daily for at least one month prior to and for six months subsequent to the modifications. Any significant degradation of water quality (beyond normal ranges) shall be corrected immediately and shall be reported to the State.

(j) Chlorine dioxide may be used as a primary disinfectant provided that the total quantity which is added to drinking water during the treatment process shall not exceed one milligram of chlorine dioxide per liter of water.

(k) Chloramines shall not be utilized as the primary disinfectant in drinking water. Chloramines may be added for the purpose of maintenance of an active chlorine residual in the distribution system only to water that already meets primary drinking water regulations.

5. By revising the title, paragraph (a) introductory text and paragraph (b) of § 141.24 to read as follows:

§ 141.24 Organic chemical other than total trihalomethanes sampling and analytical requirements.

(a) An analysis of substances for the purpose of determining compliance with § 141.12(a) and § 141.12(b) shall be made as follows:

(b) If the result of an analysis made pursuant to paragraph (a) of this section indicates that the level of any contaminant listed in § 141.24 (a) and (b) exceeds the maximum contaminant level, the supplier of water shall report to the State within 7 days and

initiate three additional analyses within one month.

6. By revising § 141.25 to read as follows:

§ 141.25 Total trihalomethanes sampling and analytical requirements.

(a) Community water systems which serve a population of greater than 75,000 individuals and which add a disinfectant to the water in any part on the drinking water treatment process shall analyze for trihalomethanes at quarterly intervals. Such analyses shall begin not later than three months after the date of promulgation of this regulation. Each analysis shall be based on samples collected at a representative entry point(s) to the water distribution system and at points throughout the distribution systems, including samples collected at the extreme ends of the distribution system. Each quarterly analysis shall be performed on at least five such samples collected on the same day and the results shall be arithmetically averaged and reported to the State and EPA within 30 days. No more than 20 percent of the samples shall be taken at the entry point(s) and at least 20 percent of the samples shall be taken at the extreme ends of the distribution system. The remaining 60 percent shall be at locations in the distribution system representative of the population being served. (All samples collected according to the above the formula shall be used in the computation of the average, unless the analytical results are invalidated for technical reasons. Analyses should be conducted in accordance with the methods listed in paragraph (d) below.

(b) Community water systems which serve a population of between 10,000 and 75,000 individuals and which add a disinfectant to the water in any part of the drinking water treatment process shall analyze for trihalomethanes at quarterly intervals. Such analyses shall begin not later than six months after the date of promulgation of this regulation and shall continue thereafter for one year. The quarterly analyses shall be performed on at least two water samples collected at the entry point to the water distribution system at the same time; one water sample shall be dechlorinated upon collection, while the other shall be retained 7 days at a temperature not less than 25° C without being dechlorinated to permit the trihalomethane reaction to proceed to completion, prior to analysis. Analyses shall be conducted in accordance with methods listed in paragraph (d) below, and trihalomethane concentrations shall be reported to the State and to EPA within 30 days.

(c) Compliance with Section 141.12(c) shall be determined on a run-

ning annual average of quarterly samples collected as prescribed in paragraph (a) of this section. If the average of quarterly samples covering any 12 month period exceeds the Maximum Contaminant Level, the supplier of water shall report to the State pursuant to Section 141.31 and notify the public pursuant to Section 141.32. Monitoring after public notification shall be at a frequency designated by the State and shall continue until a monitoring schedule as a condition to variance, exemption or enforcement action shall become effective.

(d) Sampling and analyses made pursuant to this section shall be conducted by one of the following procedures:

1. "The Analysis of Trihalomethanes in Finished Waters by the Purge and Trap Method" EMSL, EPA, Cincinnati, Ohio, September 8, 1977.

2. "The Analysis of Trihalomethanes in Drinking Water by Liquid/Liquid Extraction" EMSL, EPA, Cincinnati, Ohio, September 9, 1977. Unless otherwise indicated, samples shall be dechlorinated upon collection to prevent further production of trihalomethanes, according to the procedures described in the above two methods.

(e) The sampling frequencies required by this section may be reduced by the State to not less than one sampling every six months based upon the data from at least 1 year of compliance monitoring, upon a determination by the State that local conditions are such that trihalomethane concentrations could not approach or exceed the maximum contaminant level. A change in the source of water or treatment program shall reinstate the applicable sampling requirements of this section.

7. By adding a new Subpart F and appendix as follows:

Subpart F—Treatment Techniques for Synthetic Organic Chemicals

Sec.

141.51 Scope and purpose.

141.52 Specialized definitions.

141.53 Treatment techniques for synthetic organic chemicals.

141.54 Variance from treatment technique.

141.55 Analytical methods.

APPENDIX: Chemical Indicators of Industrial Contamination.

Subpart F—Treatment Techniques for Synthetic Organic Chemicals

§ 141.51 Scope and purpose.

(a) The provisions of this subpart shall apply to each public water system which regularly serves a population of greater than 75,000 individuals and which is not granted a variance under § 141.54 of this subpart.

(b) The treatment technique prescribed by this subpart shall be designed, constructed and operated to minimize the presence of synthetic organic chemicals in drinking water.

§ 141.52 Specialized definitions.

As used in this subpart, and except as otherwise specifically provided:

(a) "Treatment technique" means a requirement of the national primary drinking water regulations which specifies for a contaminant or group of contaminants the treatment practice(s) known to the Administrator which leads to a reduction in the level of such contaminant(s) sufficient to satisfy the requirements of Section 1414 of the Act.

(b) "Synthetic organic chemical" means an organic chemical introduced into surface or ground water sources of drinking water as a result of industrial, agricultural, or other human activities. For the purpose of this subpart, synthetic organic chemicals are distinguished from those organic chemicals naturally occurring in the environment or introduced into drinking water as a by-product of water treatment processes.

(c) "Regeneration frequency" or "re-activation frequency" means the average length of time that a given amount of granular activated carbon remains in a water treatment system before being regenerated (thermally reactivated) to a fresh state.

(d) "Granular activated carbon" means organic material which has been dehydrated and carbonized followed by activation at a temperature between 750 and 950 degrees in stream or carbon dioxide producing an internal porous particle structure. The total surface area of granular activated carbon is usually around 1,000 square meters per gram.

(e) "Contact time" means the length of time that is required for water to pass through an adsorption column, assuming that all the liquid passes through at the same velocity. It is equal to the volume of the empty bed divided by the flow rate.

§ 141.53 Treatment techniques for synthetic organic chemicals.

(a) Each public water system subject to this subpart is required to design, construct and operate a treatment system using granular activated carbon to reduce the level of synthetic organic chemicals in the finished drinking water to the maximum extent feasible not later than three and one-half years after the effective date of this regulation.

(b) The design of a granular activated carbon treatment system, installed and operated pursuant to paragraph (a) above, including specification of type of carbon, contact time, and regeneration frequency, shall be in accordance with reasonable engineering practice. In order to assure that adequate contact time is provided for the removal of a broad spectrum of synthetic organic chemicals and that regeneration or replacement of the

carbon is frequent enough to prevent saturation, the system shall be designed to consistently achieve, to the extent feasible, all of the following criteria, as determined by a running average of 3 consecutive weekly analyses.

(1) The concentration in the effluent of any of the volatile halogenated organic compounds (except for the trihalomethanes) determinable by the purge-and-trap gas chromatography method (as specified in Section 141.55) shall not exceed 0.5 µg/l;

(2) The removal of influent total organic carbon with fresh granular activated carbon shall be greater than fifty percent percent; and

(3) The effluent total organic carbon shall not exceed the values with fresh granular activated carbon by more than 0.5 mg/l.

(c) Each public water system subject to this subpart shall further comply with the following intermediate requirements:

(1) A public water system desiring a variance shall submit the request for variance by not later than the effective date.

(2) By not later than six months after the effective date of this regulation, submit to the State for approval, the design specifications for the treatment system using activated carbon to satisfy the criteria specified in paragraph (b) of this section. Such plans and specifications shall have been based on pilot studies performed using as influent the system's actual raw water or water of reasonably similar quality.

(3) By not later than eighteen months after the effective date of this regulation, submit to the State for approval, the final design plans and specifications and construction schedule for the treatment system using granular activated carbon.

(4) By not later than three and one-half years after the effective date of this regulation, notify the State that construction has been completed and that the treatment system using granular activated carbon is in operation in compliance with paragraphs (a) and (b) of this section.

(d) Unless the State determines that a public water system meets the conditions specified in paragraph (e) of this section, each public water system subject to this subpart shall replace the existing filter media in its treatment process with granular activated carbon by not later than twelve months after the effective date of this regulation. This carbon shall be replaced or regenerated once every six months, unless monitoring data shows that the design criteria specified in paragraph (b) of this section will not be exceeded for a longer period of time, whereupon the carbon shall be replaced or regenerated at that time.

(e) A State may waive the requirements of paragraph (d) of this section

if it finds that a public water system has adequately demonstrated that the failure to replace the existing filter media with granular activated carbon will not result in an unreasonable risk to health and that either:

(1) The system will comply with the requirements of paragraph (a) of this section by not later than 24 months after the effective date of this regulation; or

(2) Because of compelling physical circumstances, the cost to the system of replacing the existing filter media with granular activated carbon is unreasonably high when viewed in light of the accompanying reduction in the level of synthetic organic chemicals that would be achieved.

(3) After the treatment system is in operation each public water system subject as this subpart shall submit to the State such other information as it may reasonably require to assure that the treatment system using granular activated carbon is being operated to achieve the criteria specified in paragraph (b) of this section to the maximum extent feasible.

§141.54 Variance from treatment technique.

(a) Any public water system subject to this subpart may request a variance from a prescribed treatment technique from the State in accordance with Section 1415(a)(1)(B) of the Act and 40 CFR 142.20 or 142.40, whichever is applicable upon making the requisite showing contained in paragraphs (c), (d), and (e) of this section.

(b) If, based on consideration of all available information, including information provided in accordance with subsections (c), (d), and (e), and, to the extent feasible, information developed pursuant to Sections 208, 303(e), and 402 of the Federal Water Pollution Control Act, as amended, the State determines that the public water system's raw water sources are not subject to significant contamination from synthetic organic chemicals and that the treatment technique is not necessary to protect the health of persons from adverse effects of such chemicals, it may grant a variance in accordance with 40 CFR 142.20 or 142.40, whichever is applicable.

(c) In the absence of information to the contrary, the State may make the finding required in paragraph (b) above and grant a variance to a public water system upon a demonstration that all of the system's raw water is drawn from one or more of the following types of sources:

- (1) Deep ground water;
- (2) Watersheds protected from man-made pollution;
- (3) The Great Lakes;
- (4) Water purchased from a supplier subject to this subpart who has complied with the requirements of this subpart.

(d) Notwithstanding paragraph (c) of this section, the State may require a public water system whose raw water is of the type listed in (c)(1)-(4) to provide such additional information and to perform analyses of raw water and finished water as it deems necessary to make a determination as to whether to grant or deny a variance in accordance with paragraph (b) of this section.

(e) If any of a public water system's raw water sources is not of a type listed in paragraph (c)(1)-(4) of this section, the public water system shall submit to the State the following information as part of its request for a variance:

(1) Characterization, to the extent feasible, of both point and non-point source discharges of pollutants which are likely to be potential sources of synthetic organic chemical contamination of the system's raw water source. This may include the volume of effluent discharge, frequency of discharge, and chemical concentration in the discharge and likelihood of chemical spills contaminating the drinking water source.

(2) The results of analyses performed in accordance with §141.55 on samples of the raw water in the immediate area of all raw water intakes of the affected system for the chemicals listed in Appendix A. The analytical results, including gas chromatograms, of not less than four samples taken at least 30 days apart shall be provided.

(3) Such other information or data otherwise required by the State in order to assess the likely presence of synthetic organic chemicals in the system's raw water source.

(f) The State shall require, as a condition of any variance granted pursuant to this section, that:

(1) The public water system promptly report to the State any known circumstance which would significantly change the vulnerability of the system's raw water sources to contamination by synthetic organic chemicals; and,

(2) The public water system submit an updated report to the State at least annually concerning the information which was submitted as part of the system's request for variance under paragraphs (c), (d) or (e) of this section.

(g) Pursuant to Section 1415(a)(3) of the Act, the Administrator may grant a variance to the treatment technique specified in this subpart upon a showing by any person that an alternative treatment technique is at least as efficient in lowering the levels of a broad spectrum of synthetic organic chemicals as that specified in this subpart. A variance under this paragraph shall be conditioned on the use of the alternative treatment technique which is the basis for the variance.

§ 141.55 Analytical methods.

(a) Analysis pursuant to § 141.53(b) and § 141.54(e)(2) shall be conducted according to the following methods:

(1) "The Analysis of Trihalomethanes in Finished Waters by the Purge and Trap Method," Environmental Monitoring and Support Laboratory, EPA, Cincinnati, Ohio, September 9, 1977.

(2) "The Analysis of Trihalomethanes in Drinking Water by Liquid/Liquid Extraction," Environmental Monitoring and Support Laboratory, EPA, Cincinnati, Ohio, September 8, 1977.

(3) "Method for Organochlorine Pesticides in Industrial Effluents," MDQARL, EPA, Cincinnati, Ohio, November 28, 1973.

(4) Hunt, D. C., Wild, P. J., and Crosby, N. T., 1977. "Phthalimido-propylsilane—A New Chemically Bonded Stationary Phase for the Determination of Polynuclear Aromatic Hydrocarbons by High-Pressure Liquid Chromatography." *Journal of Chromatography*, 130: 320-323.

(5) "High Pressure Liquid Chromatography for the Measurement of Polynuclear Aromatic Hydrocarbons in Water." Sorrell, R. K., Dressman, R. C., and McFarren, E. F., AWWA Water Quality Technology Conference, Kansas City, Mo., December 1977.

(6) "Ultra Low Level TOC Analysis of Potable Waters." Takahashi, Toshihiro, AWWA Water Quality Technology Conference, San Diego, Calif., 1976. AWWA Denver, Colo., 1977.

(7) Lingg, D. R., Melton, R. G., Kopfler, P. C., Coleman, W. E., and Mitchell, D. E., "Quantitative Analysis of Volatile Organic Compounds by GC-MS," *Journal AWWA*, November 1977, pp. 605-612.

(8) Munch, D. J., Feige, M. A., Brass, H. J., "The Analysis of Purgeable Compounds in the National Organics Monitoring Study," AWWA Technical Conference Proceedings, Kansas City, December 6, 1977.

(9) U.S. Environmental Protection Agency. "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants," Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

APPENDIX A—CHEMICAL INDICATORS OF INDUSTRIAL CONTAMINATION

Industrial Chemicals

Benzene,
Bis (2-chloroethyl)ether,
Bis (2-chloroisopropyl)ether,
Bromobenzene,
4-Bromophenylphenyl ether,
Carbon tetrachloride,
Chlorinated Naphthalenes,
Chlorobenzene,
4-Chlorophenylphenyl ether,
Chlorophenols,
2-Chlorovinyl ether,
Dichlorobenzenes,
Dichlorodifluoromethane,
1,1-Dichloroethane,
1,2-Dichloroethane,
1,1-Dichloroethene,
1,2-Dichloroethene,
Dichloromethane,
1,2-Dichloropropane,
1,3-Dichloropropene,

Dinitrotoluenes,
Ethylbenzene,
Hexachlorobenzene,
Hexachlorobutadiene,
Hexachlorocyclopentadiene,
Hexachloroethane,
Nitrobenzene,
Phthalate esters,
Polychlorinated biphenyls,
Propylbenzene,
Styrene,
1,1,2,2-Tetrachloroethane,
Tetrachloroethylene,
Toluene,
Trichlorobenzenes,
1,1,1-Trichloroethane,
1,1,2-Trichloroethane,
Trichloroethylene,
Trichlorofluoromethane,
Vinyl Chloride, and
Xylenes.

Pesticides

Aldrin,
Atrazine,
Chlordane,
DDD, DDE, DDT,
Dieldrin,
Endrin,
Heptachlor,
Heptachlor epoxide,
Kepone,
Lindane and Hexachlorocyclohexanes,
Pentachlorophenol, and
Toxaphene.

Polynuclear Aromatic Hydrocarbons

3,4-Benzofluoranthene,
1,12-Benzoperylene,
11,12-Benzofluoranthene (Benzo(K) Fluoranthene),
Benzo(a)pyrene,
Fluoranthene, and
Indeno(1,2,3-cd)pyrene.

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